WEB-BASED DIGITAL RESOURCES AND SERVICES: TRENDS AND INNOVATIONS

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0. Introduction

The history of mankind has already witnessed three revolutions and it is on the threshold of fourth. The first revolution took place hundreds of thousand of years ago when language first emerged. The second cognitive revolution was the advent of writing, tens of thousands of years ago. The third revolution took place in our own millennium with the invention of printing press in 1500. The post Gutenberg's era witnessed complete and absolute control of printing technology and printed artifacts as a media of scholarly communication over scientific and literary world. The Internet and its application offshoot, i.e. World Wide Web and the electronic publishing, represent fourth revolution that has humbled monopoly of printed artifacts as sole media of scholarly communication. The revolution is likely to have lasting impact on the publishing and information delivery system in 21st century.

The emergence of Internet and the World Wide Web (WWW) as a new media of information storage and delivery provide an unparalleled media for delivery of information with greater speed and economy. The Internet and web technology has already changed the way information is stored, retrieved, communicated and broadcasted, it is likely to revolutionized the way publishers, publishing industry and scientists functioned in the era predominately guided by the printing technology. These technologies have triggered large-scale commercial and non-commercial digitization programmes the world over because digital contents are infinitely malleable and globally deliverable across the networks. Increasing number of commercial and society publishers are using the Internet as a global way to offer their publications to the international community of scientists and technologists. Resultantly, increasingly large numbers of STM (Science, Technology and Medical) electronic journals are appearing on the web. The web-based electronic information products not only eliminated paper, physical storage and transportation costs, it also offer a hosts of other possibilities for incorporating multimedia and hyper-link features to electronic documents hitherto impossible on paper media.

The technology-led developments have created new opportunities and challenges for the players involved in creation, promotion, mediation and storage of information. This, in turn, has led to the generation of new services hitherto non-existence as well as modification of existing services and their deliverables. The web-based digital resources and services cannot, however, be discussed in isolation. It would be imperative to take up other associated activities and functions whose coordinated and concerted use generate web-based digital resources and services.

This article delves into technological evolution, cultural revolution and contents enrichments that led to modified and newly added web-based library services. The article touches upon various aspects of building, accessing and organizing digital resources and collection. Hardware and software infrastructure requirements, both at server-end and client-end are enumerated. Lastly the article describes i) web-bases library services that are modified versions of existing services; and ii) technology-driven web-based library services. Digital resources and digital library are used interchangeably in this article given the fact that digital resources are basic and important ingredients of a digital library.

1. Evolution of Digital Resources and Services

Although the terminology associated with the digital resources and digital services gained popularity in the last decade of 20th century, it has, however, evolved along the technological ladder for past thirty years. In early 1970s, information systems for libraries were built around mini and mainframe computers providing remote access and online search and retrieval services to users. It was around this time when the libraries, especially in the developed world started applying a growing range of information technology to the management of the predominantly print collections available in the libraries. Several integrated library packages were launched to automate in-house functions of the Library including circulation of books, ordering of books and online public access catalogue (OPAC). Online public access catalogue came as a replacement for the traditional card catalogue that made the manual processes more efficient, and also opened-up the library collections to the researchers (Lynch, Clifford, 2000). Through the online catalogue, users could search the holdings of the library from remote location without having to come to the library. As the Internet began to grow, several Library catalogue, with their web interfaces, started appearing on the net which could be accessed remotely from anywhere in the world.

Creation of online bibliographic databases was another landmark in the library-related information technology applications. Sophisticated online databases were built during 1970s and 1980s using state-of-the-art technology of distributed database management system linking different remote systems using data files generated in the process of electronic phototypesetting of printed abstracting and indexing services and other primary journals. As such, online hosts like DIALOG and STN were not only offering online databases but also full-text online journals for past several years, although as a simple ASCII or text files without graphics and pictures. In 1989, there were almost 1,700 full-text sources in sixteen online systems. Availability of CD ROM in late 1980s, as a media with high storage capacity, longitivity, and ease of transportation triggered production of several CD ROM information products which were earlier available through online vendors or as conventional abstracting and indexing services in printed format. Moreover, several full-text databases also started appearing in late 1980s and early 1990s launching the beginning of digital era. Some of the important full-text digital collections available on CD ROM include: ADONIS, IEEE / IEE Electronic Library (IEL), ABI/INFORM, UMI's Business Express and Library & General Periodicals, Espace World, US Patents, etc.

Online Public Access Catalogues (OPAC) as well as online bibliographic databases can only be used to find bibliographic details without their contents in full-text. The need was felt for full-text articles in digital format. Prior to WWW, the beginning of full-text "digital library" involved building-up several client systems usable in a multitude of environments. However, 1990s brought-in a true revolution in network-based digital services with advent of World Wide Web (WWW). The WWW offered web server at the server-end and web browser at the client-end for all prevalent platforms. The availability of ready-to-use, publicly available, user-friendly graphical web browser for all prevalent platforms eliminating the need of extensive support and user's training. Standard WWW clients such as Netscape Navigator and Internet Explorer are being upgraded regularly for added functionality such as e-mail client, support for JAVA and Active X and the ability to view important document formats without having to install plug-ins for them. HTML, the de facto language of the web, is extremely simple yet powerful tool for presentation of web-based services. The static HTML web pages can be transformed into vibrant, dynamic and interactive web creations using ever evolving web technologies like CGI Script / Perl, Java, JavaScript, ASP, DHTML, XML and open database connectivity (ODBC) for delivering web-based services. The Internet and associated technologies, made it possible for web-based services to include multimedia objects such as text, image, audio and video. These technologies thus brought in the graphical components in web-based services that were missing in earlier full-text automated services.

There has thus been a steady move up the technological scale for IT applications in the libraries from online bibliographic databases and OPAC to low-end electronic publications available as ASCII files, to being organized and searchable on gophers (1992), and to being tagged and graphically viewable full-text systems (digital libraries) on World Wide Web sites (1994). Side box 1 lists major shift in technology and its applications that led to the development of web-based library services. Side box 2 lists cultural and ideological shift consequent to major technological upheaval.

Side Box 1

Technological Changes: Web Technology

From Gopher to WWW

Gopher pre-dates the World Wide Web and could accommodate only text. A Gopher server presents its contents as a hierarchically structured list of files. With the ascendance of the Web, most Gopher databases are being converted to Web sites. World Wide Web is a system of Internet Servers that support documents formatted in HTML that support links to other documents, as well as graphics, audio and video files. There are several applications called web browsers that make it easy to access the WWW. Two of the most popular Internet browser are Netscape Navigator and Microsoft's Internet Explorer.

From CGI+Perl to ASP

Common Gateway Script (CGI) programming, often written in PERL, was the first method developed to processing data in web forms, and it still has place in development of complex web applications. However, several common task can now be accomplished using Active Server Pages Technology and VBScript. ASP Server Side Scripts are usually written in VBScript. ASP technology requires Windows NT Internet Information Server. Unix and complaint web server can use ASP with add-on available from Chili!Soft or other vendors.

From HTML to DHTML to XML

Hypertext Markup language (HTML), the de facto language of the web, is extremely simple yet powerful to use. Dynamic HTML is a set of technologies ranging from HTML extensions to programming features designed to allow web authors to create more interactive pages that respond to users actions. XML (Extensible Markup Language), developed especially for web documents by the W3C, is a pared-down version of SGML. It allows designers to create their own customized tags, enabling the definition, transmission, validation, and interpretation of data between applications and between organizations. Whether XML eventually supplants HTML as the standard Web formatting specification depends a lot on whether it is supported by future Web browsers. Microsoft Internet Explorer version 5 handles XML, but renders it as CSS.

Technological Changes: Scripting Languages

JavaScript

JavaScript codes are embedded in HTML documents and run on the browser side. JavaScript provides interactivity to a web page so essential for digital library implementations. As oppose to VBScript, JavaScript is usually used for client-side validation.

Java, Java Applets and Servlets

Java is an object-oriented language similar to C++, but simplified and made suitable for the web. Compiled Java code can run on most computers. Small Java applications are called Java applets and can be downloaded from a Web server to run on client machine. Applets that runs on a server are called Servlets. Java servlets are becoming increasingly popular as an alternative to CGI programs.

Side Box 1

Technological Changes: Network Technology

From Host-terminal to Client-Server / Peer-to-Peer Architecture

Most online search services worked on host / terminal architecture where a centralized mainframe host is accessed by relatively dumb character-based terminals. In network based **Client-server architecture,** servers are powerful computers or processes dedicated to managing disk drives hosting resources. Clients are PCs or workstations on which users run client applications to access resources on the servers. Peer-to-peer is another type of network architecture where each node has equivalent responsibilities. Both client / server and peer-to-peer architectures are widely used, and each has unique advantages and disadvantages.

From IP Validation to Patron Validation

Most electronic publisher allow IP address authentication. Technologies are available that allow secure access to vendor's server from legitimate patrons who are not on an institutional LAN. Use of CGI scripting / proxy servers allow a subscribing institution to authenticate patrons from its server and then pass them through to the vendors with the assurance that they are infact legitimate costumers irrespective of their log-in location.

Technological Changes: Databases

Large Central Database to Distributed Smaller Databases

The technology now supports services from smaller distributed databases that are more manageable in comparison to large central databases. The scattered databases may have to be periodically synchronized to make sure that they all have consistent data.

From Online Search Services to Web-based Search Services

Most Online Search Services like DIALOG and STN now have web-based interfaces that makes them much easier for novice users to search.

Side Box 2

Cultural and Ideological Shifts

Ownership to Access on Demand

Accessibility of resources on the Internet has triggered a shift in the acquisition process from the policy of "Ownership" to "Access on Demand".

"Just in Case" to "Just in time"

Traditional practices and policies of buying and storing journals in libraries on the basis of "Just in Case" are being challenged by the advent of full-text electronic resources causing a shift in acquisition from "Just in Case" to "Just in time".

Library as Physical Entity to Library as an Information System

With increase in digital resources available in libraries or accessible from a library, the libraries are being viewed not as a physical entity but as information system that facilitate access to electronic resources.

Collection Building in Anticipation to Need-based Collection Building

Increased availability of full-text electronic resources has caused shift to need-based collection building from collection building in anticipation.

Library as Provider of Information to Library as Intermediary Facilitator

With proliferation of network-based information resources made accessible through the libraries subject gateways, the librarians are being considered as information facilitator.

2. Technical Infrastructure

Establishing digital library resources and services require a great deal of new technical infrastructure that is not available off-the-shelf as packaged solution. Use of open architecture and standard protocols, however, makes it possible that pieces of required infrastructure, be it hardware, software or accessories, are gathered from different vendors in the marketplace and integrated to construct a working environment. Several constituents of technical infrastructure established for generating and distributing web-based library services would be internal to the institutions, but several others would be distributed across the Internet, owned and controlled by a large number of independent players. The task of raising technical infrastructure for generating web-based library services, therefore, requires a great deal of integration of various components (Flecker, D., 2000). Technical infrastructure required for generating web-based library services can broadly be divided into the following three categories:

- **Collection infrastructure**
- **Access infrastructure**
- **Hardware & Software Infrastructure**

Figure 1 is a pictorial representation of inputs required for generation of web-based digital resources.

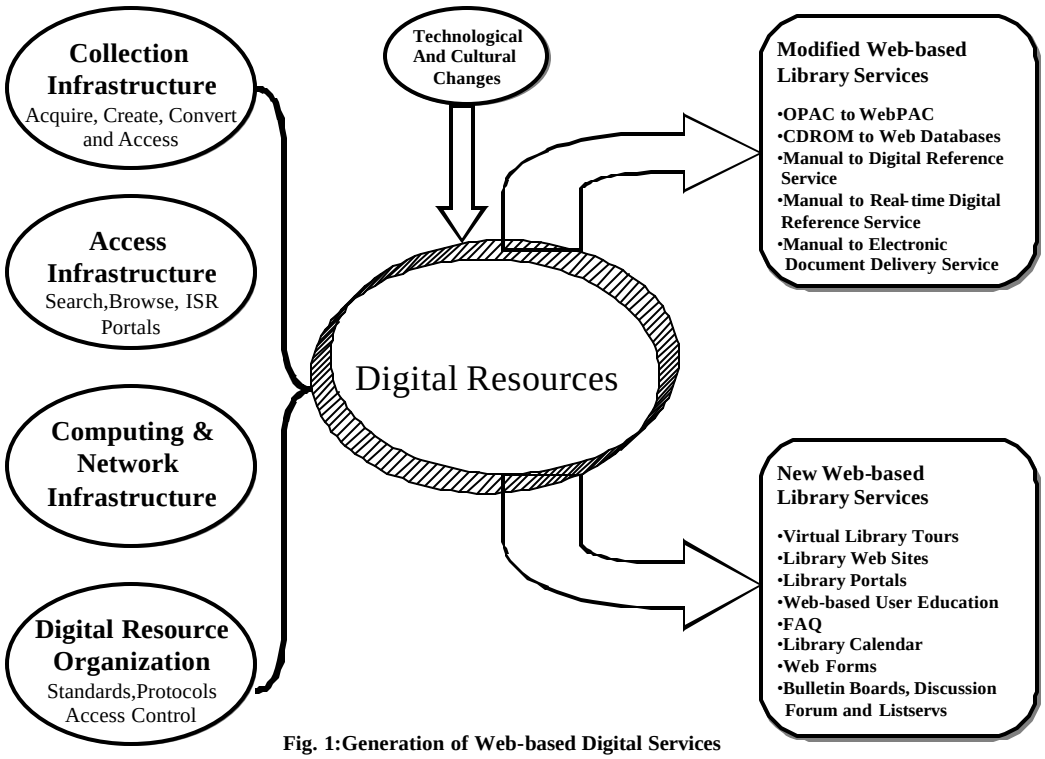


Fig. 1:Generation of Web-based Digital Services

3. Collection Infrastructure

The physical libraries are unlikely to get transformed into digital libraries. Most libraries would, however, acquire access to the ever-growing digital collections including those developed by scholarly societies and commercial organizations. A major portion of library's digital collection would be provided through external systems providing access to e-journals and other electronic resources. The libraries would, however, have significant local collections in digital form as it continue to digitise its local contents or acquire collections in digital form. The contents of a digital collection would come from different sources inside or outside the institution. The pictorial representation of digital constituents of a digital library is given in figure 2 and are described below:

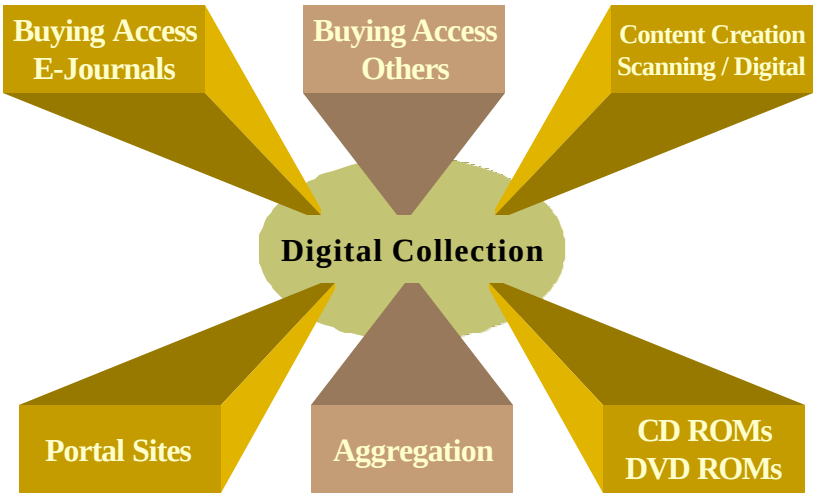


Fig. 2: Collection Infrastructure for Web-based Digital Services

3.1 Acquisition of Digital Resources

Availability of CD ROM, and more recently DVD ROM, as a media with high-storage capacity, longitivity and ease of transportation, triggered production of several CD ROM-based information products including several bibliographic databases which were earlier available only through online vendors or as abstracting and indexing services in printed format. Thousands of CD ROM databases are currently available from multitude of CD ROM producers including Silver Platter, which alone produces more than 200 CD ROM information products. Moreover, several full-text databases also started appearing in late 1980s and early 1990s launching the beginning of a new digital era. Some of the important full-text digital collections available on CD ROM include: ADONIS, IEEE / IEE Electronic Library (IEL), ABI/INFORM, UMI's Business Express and Library and General Periodicals, Espace World, US Patents, etc. CD ROM networking technology is now available for providing web-based simultaneous access to CD ROM databases on the Local Area Network (LAN) as well as on Wide Area Network (WAN). More evolved technology allows caching the contents of CD ROMs on to a server, which, in turn, provides web-based simultaneous and faster access to the information contents of CD ROMs on LAN / WAN. The libraries have an option to subscribe to these full-text databases as a part of their digital resources.

3.2 Buying Access to Digital Resources

The Internet has long been a favorite media for experimenting with electronic publishing and delivery. The technology is now available that allow creation of fully digitized multimedia products and their accessibility through the Internet. Technological changes, especially the Internet and web technology, continue to attract more and more traditional players to adopt it as a global way to offer their publications to the international community of scientists and technologists. Most of the important publishers now have their web-based interfaces to offer full-texts of

their journals. Some of the major players in electronic full-text journal publishing include:

Elsevier Science Publishers (Science Direct)	*http://www.sciencedirect.com/*
Academic Press (Ideal Library)	*http://www.idealibrary.com/*
Springer Verlag (Link Electronic Service)	*http://link.springer.de/*
American Chemical Society (ACS)	*http://pubs.acs.org/*
Wiley Interscience	*http://www.wileycom/*
American Physics Society (APS)	*http://publish.aps.org/*

Total number of electronic journals, one of the corner stone of the digital library, available on the web has grown steadily from less than 10 in 1989 to 3634 in 1997 (ARL, 1997). These journals are made available through the web at varying price models. The electronic subscription to journals in most of the cases are linked to its printed counterparts, i.e. it may be offered free with print subscription (e.g. publications of American Society for Physics and AIChE) or priced at a fixed % over the print subscriptions (e.g. journals published by Elsevier Science, Springer Verlag and IEEE) or it may also be offered exclusively in electronic media.

Besides, electronic journals, there are several online databases that are now available through the web including Medline (several versions), AGRICOLA and ERIC (all free). Reference works like encyclopedia, dictionaries, handbooks, atlases, etc. are also making their electronic appearance on the web. However, amongst electronic resources created exclusively for the web, imbibing all features and facilities offered by the new technology, include web-based educational tutorials called "online courseware". The online courseware are proliferating the web as a strong contender for distant education. Telecampus, Canada (***www.telecampus.edu/***) lists more than 12,000 online courseware available on the web. Moreover, highly specialized web sites are now coming-up in various disciplines which offer information in totality including all kinds of resources in electronic format, EI Engineering Village (***http://www.ei.org/***), ISI Web of Science (***http://www.isinet.com/***), ACM Digital Library (***http://www.acm.org/dl/***) IEEE / IEE Electronic Library (***http://www.ieee.org/ieeexplore/***), Engineering Sciences Data Unit (***http://www.esdu.com***) are some of the important examples.

3.3 Conversion of Existing Print Media into Digital Format

Several digital library projects are concerned with providing digital access to materials that already exists with traditional libraries in printed media. Scanned page images are practically the only reasonable solutions for institutions such as libraries for converting existing paper collection without having access to the original data in computer processible formats convertible into HTML / SGML or in any other structured or unstructured text. Scanned page images are natural choice of large-scale conversions for major digital library initiatives. Printed text, pictures and figures are transformed into computer-accessible forms using a digital scanner or a digital camera in a process called document imaging or scanning. The digitally scanned images are stored in a file as a bit-mapped page image, irrespective of the fact that a scanned page contains a photograph, a line drawing or text. A bit-mapped page image is a type of computer graphic, literally an electronic picture of the page which can most easily be equated to a facsimile image of the page and as such they can be read by humans, but not by the computers, understably "text" in a page image is not

searchable on a computer using the present-day technology. An image-based implementation requires enormous disc space for data storage and transmission. There are several large digital library projects using page images as their primary storage format, including project JSTOR (***www.jstor.org***) at Princeton University funded by the Melon Foundation. The project Jstor has a complete set of more than 120 journals scanned and hosted on web servers that resides at the University of Michigan and is mirrored at Princeton University. Using technology developed at Michigan, high resolution (600 dpi) bit-mapped images of each page are linked to a text file generated with optical character recognition (OCR) software. Linking a searchable text file to the page images of the entire published record of a journal along with newly constructed table of contents, indexes, permits high level of access, search and retrieval of the journal material previously unimaginable (Guthrie, 1997).

Capturing page image format is comparatively easy and inexpensive, it is a faithful reproduction of its original maintaining page integrity and originality. The scanned textual images, however, are not searchable unless it is OCRed, which in itself is highly error prone process especially when it involves scientific texts.

3.3.1 Optical Character Recognition (OCR)

A scanned document is nothing more than a picture of a printed page. It cannot be edited or manipulated or managed based on their contents. In other words, scanned documents have to be referred to by their labels rather than characters in the documents. OCR (Optical Character Recognition) programs are software tools used to transform scanned textual page images into word processing file. OCR or text recognition is the process of electronically identifying text in a bit-mapped page image or set of images and generate a file containing that text in ASCII code or in a specified word processing format leaving the image intact in the process. The OCR is performed in order to make every word in a scanned document readable and fully searchable without having to key-in everything in the computer manually. Once a bit-mapped page image has gone through the process of OCR, a document can be manipulated and managed by its contents, i.e. using the words available in the text.

OCR does not actually convert an image into text but rather creates a separate file containing the text while leaving the image in tact. There are four types of OCR technology that are prevailing in the market. These technologies are: matrix matching, feature extraction, structural analysis and neural network.

i. **Matrix / Template Matching:** Compares each character with a template of the same character. Such a system is usually limited to a specific number of fonts, or must be "taught" to recognize a particular font.

ii. **Feature Extraction**: Can recognize a character from its structure and shape (angles, points, breaks, etc.) based on a set of rules. The process claims to recognize all fonts.

iii. **Structural analysis:** Determines characters on the basis of density gradations or character darkness.

iv. **Neural Networking:** Neural networking is a form of artificial intelligence that attempts to mimic processes of the human mind. Combined with traditional

OCR techniques plus pattern recognition, a neural network-based system can perform text recognition and "learn" from its success and failure. Referred to as "Intelligent Character Recognition", neural network-based systems are being used to recognize hand-written text as well as other traditionally difficult source material. Neural network ICR can contemplate characters in the context of an entire word. Newer ICR combines neural networking with fuzzy logic.

4. Access Infrastructures

An effective and efficient access mechanism that allow a user to browse, search and navigate digital resources becomes necessary as electronics resources of a collection grow in number and complexion. The access infrastructure for a digital resource consists of webPACs, multi-webPACs for library catalogues, specialized collection web sites for specialized image-based local collection, portals or subject gateways for web resources and a search and browse interface for local collections.

4.1 Search and Browsing Interfaces

The search interface provides a visual window for users to search relevant information stored in a digital resource. Designing interfaces for digital resources involve use of principles and practices of information management with rapidly evolving technological developments. The interfaces should maximize the interaction with information resources and minimize their attention to the system itself. Moreover, a web-based interface should support both browsing and searching strategies. Marchionini (1998) prescribes following goals for designing an interface for a digital library:

i. Minimize disorientation by reducing navigation and anchoring users in a consistent context;

ii. Provide primary information at the earliest point in the interaction as possible instead of forcing a user to navigate through deep menu hierarchies or execute a query; and

iii. Support rapid relevance decisions through over viewing and previews.

New developments in web technology allow creation of user-friendly interfaces providing features and facilities hitherto impossible in traditional command-based or menu-based search interfaces. Several important search components that a user had to input in a menu-based or command-based interfaces can be given in selection / combination boxes or radio buttons for a user to select from. New opportunities and better search interfaces in the web environment has attracted many online search services to migrate to the new technology. Some of the important features that most digital library implementations provide in their search interfaces include:

i. Distinct option for browsing / searching the digital contents;

ii. Searching the digital library contents with one or more of the following restrictions provided as radio buttons / selection boxes / combination boxes:

a. Range in terms of number of years;
b. A predefined collections / category of documents or all documents;
c. Searching a given digital library or search the Internet for a given subject;
d. Select maximum number of hits desired; and
e. Sort results (by author, title, jour nals, etc.)

Besides search interface, a browsing interface is also a necessity for a digital resource to give a user a sense of the amount and variety of material and the attributes of these materials available in a digital library. Taking advantages of flexibility of electronic presentation, digital libraries can have several options for browsing the collection. Browsing helps a user in selecting collection and locating sets of items in a collection with similar attributes. It helps a user to learn about the collection in general, topics covered and kinds of material available in a digital collection (Marchionini, 1998). Thus helping them to formulate their search queries. The browsing facility may have a combination of attributes, which may include, year, type or format of material, topics or subject, physical or geographical locations, etc. Browsing options for a digital resource can be dynamic query-based interface or table of content (ToC) interface based on directory and file structure of the site.

4.2 Information Retrieval

A typical digital library implementation may employ a variety of information retrieval techniques including meta data searching, full-text document searching and content searching or combination or two or all of them. Information retrieval is made more effective and user's-friendly by preprocessing digital documents to extract additional metadata before storing them in a database. The database is then configured to generate indices from selected fields including author(s), titles, abstracts, etc. or it may also be configured to generate indices from the full-text articles with a pre-defined stop-word list. The success of information retrieval can be measured in terms of percentage of relevant.

"Contents" or "Table of Contents" (ToC) primarily extend a browsing interface to the users although search can also be restricted to the ToC in a digital library implementation.

4.3 Portal or Knowledge Gateways

The portal sites or subject gateways redirect a user to the site holding the original material. A detailed description of portals or subject gateway is given under "Newly added Web-based Services" in this article.

5. Hardware and Software Infrastructure

A typical digital library in a distributed client-server environment consists of hardware and software components at server side as well as at client's side. Clients

are machines that are used for accessing digital library by users while the server hosts databases, digital objects, browse and search interfaces to facilitate its access.

5.1 Server-side Hardware Components

5.1.1 Servers

Servers are the heart of a digital library. Server for digital library implementation need to be computationally powerful, have adequate main memory (RAM) to handle the expected work, have large amount of secure disc storage for the database(s) and digital objects and have good communication capabilities. A digital library may need a number of specialized servers for different tasks so as to distribute the workload on to different servers. It would require one or more library server(s) to host indices and databases and one or more object server(s) to store digital objects and other multimedia objects. However, for a smaller library, many distinct activities can be performed on a single server. It is important that the server is scalable (such as Sun Enterprise Server) so that additional storage, processing power or networking capabilities can be added wherever required.

5.1.2 Input Devices

Image-based digital library implementation requires input devices like scanners, digital cameras, video cameras and PhotoCD systems. A large range of choices is available for these image capturing devices. Scanners are available in all sizes and shapes. Flatbed scanners or digital cameras mounted on book cradle are more suitable for libraries.

5.1.3 Storage Devices

Since digital libraries require large amounts of storage, particular attention needs to be given on the storage solution. Digital library collections that are too large to store entirely on a disk use hierarchial storage mechanisms (HSM). In an HSM, the most frequently used data is kept on fast disks while less frequently used data is kept in nearline such as an automated (robotic) tape library. An HSM can automatically migrate data from tape to disk and vice-versa as required. Intelligent storage networks and snapservers are now available in which the physical storage devices are intelligently controlled and made available to a number of servers. Although harddisc (fixed and removable) solutions are increasingly available at an affordable cost, optical storage devices including WORM, CD-R, CD ROM, DVD ROM or opto-magnetic devices in standalone or networked mode, are attractive alternatives for long-term storage of digital information. Optical drives record information by writing data onto the disc with a laser beam. The media offer enormous storage capabilities. A number of RAID (Redundant Array of Inexpensive Disks) models are also available for greater security and performance. The RAID technology distributes the data across a number of disks in a way that even if one or more disks fail, the system would still function while the failed component is replaced.

5.1.4 Communication Devices

Setting-up a digital library also require communication equipment like communication switches, routers, hubs, repeaters, modems and other items required in a Local Area Network. These hardware and software items are required for setting-up any network and are not specific to a digital library.

5.2 Server-side Software Components

A typical digital library require a number of software which may be obtained as a single integrated package from a single vendor or it may be a system with components added onto an open architecture framework. IBM Digital Library and Elsevier's Science Server are amongst very few integrated digital library solutions that are commercially available.

IBM Digital Library (Hulser, 1997) is an integrated solution for storage, management and distribution of all types of digital contents including text, images, audio and video. It incorporates functions of creating & capturing, storage & management, search & access, distribution and right management of digital intellectual contents in an open, scalable, multi-platform environment such as Windows NT and AIX. The IBM Digital Library's successful installation include: ISI Electronic Library Project, Indiana University School of Music, Case Western Reserve University and the State University System of Florida.

Elsevier's Science Server (Science Server, 1999) provides an effective and powerful information system that provides an integrated access to databases and digital collections hosted on the local intranet servers as well as other international bibliographic and full-text databases that the Library is authorized to use. In effect, it provides easy and centralized access to multiple information sources including local intranet resources (local electronic journals & abstracting and indexing services) and remote subscribed Internet services (electronic journals and online databases) through a single interface. Science Server offers tools to create a fast, powerful system with proven scalability and performance, browsing and full-text searching capabilities from a single intuitive web interface. The Science Direct supports several platforms including Sun Solaris, Digital Unix, HP Unix, IBM AIX, Unix and Windows NT.

A number of digital libraries are being constructed at present utilizing a mixture of information retrieval, media management and web server packages. All these pieces of software need to be integrated so as to present a cohesive environment and to avoid problems with growth and expansion. Some of the important software used in construction of a digital library are:

5.2.1 Web Servers

Setting-up a web-based digital library requires a web server program. Many server programs are available for different platforms, each with different features and cost varying from free to very expensive. Some of the important web server programs are HTTPD (NCSA), Apache 6.0, Jigsaw 2.1.1, Netra, Internet Information Server (IIS).

5.2.2 Image Capturing or Scanning Software

The process of converting a paper document into a computer-processible digital image is done using a software variably called document imaging system, electronic filing system or document management system, etc. Several document management software are available in the market. A simple scanning software also comes with the scanners.

5.2.3 Image Enhancement and Manipulation

The captured images may need manipulation to enhance their quality. Some of the image enhancement features include: filters, tonal reproduction, colour management, touch, crop, image sharpening, contrast, transparent background, etc. Important image enhancement packages include Adobe's Photoshop 5.5 and Paintshop Pro 6.02.

5.2.4 Information Retrieval

Internet search engines may be used on their own or be connected to an Integrated library system or DBMS to provide a fully searchable collection. All Internet search engines are basically free text search engines, i.e. they index each and every word in a document. Important search engines that can be downloaded for installation at the local site (free of cost) or can be interfaced to a local site for search are: ICE: Indexing Kit for Web Servers, Extropia, Oingo Free Search, Swish-E, Web Search, WhatyoUseek intraSearch, Excite, Google, etc.

Besides, a number of information retrieval software packages offer global finding aids that make an entire digital collection more accessible, i.e. without sacrificing the metadata and thesauri of each individual resource. These packages are: KnowledgeCite Library, Database Adviser, Pharos, Northern Light, etc.

5.2.5 Optical Character Recognition (OCR) Software

Most document imaging software have OCR package in-built. However, OCR packages are also available as separate utilities. Important OCR packages are: Text Bridge (Xerox) and OmniPage (Caere).

5.2.6 Database Management Software

The database management software provides structured storage and retrieval facilities to the contents of a digital library. Digital libraries use a variety of database management system ranging from relational and extended relational database management systems to object-oriented database systems. Relational DBMS are most often used for the storage of metadata and indices with attributes that contain pointers to files in a file system. Most of the commercial RDBMS also support storage of binary large objects (BLOBs). Object-oriented database systems are slowly gathering acceptance. The relational DBMS software that can be accessed by using SQL (structured Query Language) are: Oracle, Informix, Sybase, SQL Server, etc.

5.3 Client-side Hardware & Software Components

Clients are the machines that reside on the user's desks. Planners of the digital library, therefore, need to prescribe minimum level of hardware and software that a user would require so as to achieve efficient and effective interaction with the digital library. Most digital library require an Internet-enabled multimedia PC (or Machintosh) equipped with an Internet Browser like Internet Explorer or Netscape Navigator as their clients. The client-side PCs may also require the following software packages (plug-ins) to download format-specific deliverables from a digital library:

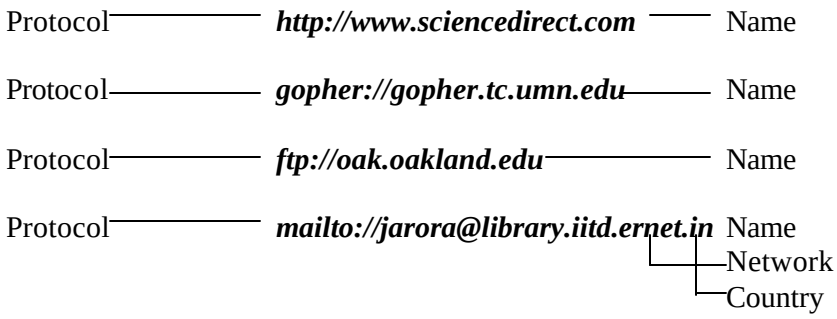
Software	Used For	Web Site
Internet Explorer 5.0	Internet Browser	http://www.microsoft.com/
Netscape Navigator 6.0	Internet Browser	http://home.netscape.com/
Acrobat Reader 4.0 (Adobe)	PDF files	http://www.adobe.com/
Real Player 7.0	Audio and Video	http://www.real.com/
WS_FTP Pro 6.0	File Transfer Client	http://www.ipswitch.com/

6. Knowledge Organization in Digital Libraries and Digital Resources

Digital contents in a digital library may include a combination of structured / unstructured text, numeric data, scanned images and other multimedia objects. These digital objects need to be organized and made accessible to the user community. As digital libraries are built around www and Internet Technology, it uses object and addressing protocols of the Internet.

6.1 Object Naming and Addressing

Uniform Resource Locators (URLs) describe the location of an object on the Internet and the protocol used to access it. URL is a pointer or an address to information available on the Internet, be it a document on the web, a file on FTP server or Gopher, a posting on USENET or an e-mail address. For example:



The URL provides a universal and consistent method for finding and accessing information on the web. They are the links between sites or pages on the web that can be linked or hyperlinked to provide the navigational functionality of the web. All digital libraries have their URLs. The concept of URN (Uniform Resource Name) was developed to make retrieval more efficient. It is proposed that schemes are created whereby object would be registered with a name server in a system of name servers and issued with a unique identity. Implementation of URNs would ensure availability of objects even if the location of objects were changed. The OCLC has developed a cataloguing standard that would appear to be the first step towards implementing URNs. PURL (Persistent URL) is functionally a URL but instead of pointing directly to the location of an Internet resource, it points to an intermediate PURL with a URL and complete the appropriate network transfer. Thus a PURL can stay constant and only the resolver need be notified when a URL changes. The Corporation for National Research Initiatives has implemented a “handle” system. A “handle” is a unique string used to identify digital objects. The handle is independent of the location where the digital objects are stored and can remain valid over very long period of time. A global handle server provides a definitive resource for legal

and archival purposes, with a caching server for fast resolution. The computer system checks that new names are indeed unique, and supports standard user interfaces such as Internet Explorer or Netscape Navigator.

6.2 Open Database Connectivity (ODBC)

6.2.1 ODBC Drivers

Open database connectivity provides a uniform way to access databases for which compliant drivers have been written. The ODBC drivers are readily available for well known relational database systems and some of the full-text retrieval ones. Working with ODBC gives access to the widest variety of systems. The technology is now available to create web pages on the fly to include data dynamically obtained from a database like Oracle, Mic rosoft Access, Inmagic, BASIC+, etc. ODBC drivers for important databases are already in-built in major operating systems.

6.2.2 Common Gateway Interface (CGI)

HTML, the de facto language of the web, does not offer much interactivity essential in a digital library implementation. Restrictions inherent in the current WWW protocol are overcome by employing Common Gateway Interface (CGI). A CGI script is an extremely powerful feature to achieve web browser and server interaction. A CGI script is a program that runs on a web server. It serves as a link between the web server and some other program (a database) running on the server. The web interfaces can now be designed to query databases, receive results and display them to the users. The program is held on the web server and activated within the web page in conjunction with HTML "forms" for query formulations by using CGI scripts. The HTML forms, filled-in by a user, generate a query for the library server. The results obtained from the Library Server are displayed once again with help of a CGI scripts which generate an HTML page for displaying the results at the user's end. The Libsys software has a CGI-based web interface. Almost any programming language can be used to write CGI scripts as long as it is supported by the server. Perl, C / C++ and UNIX Shell programming are some of the popular scripting languages.

6.2.3 Java Database Connectivity (JDBC)

Java applets are not just for creating visual effects and animations, database access is another popular application where Java applets are used. Java applets are client-end applications that get automatically transmitted to the client's PC over the Internet. Java Database Connectivity (JDBC) is a programming interface which allows applets to communicate with database systems through Servlets in a three tier architecture. The applets interact with server, which in turn, interact with database layer. In response, server receives data from the database layer and sends the results back to the client. Java is very significant since it makes the WWW truly interactive by incorporating applications that can be programmed, run online and distributed in a simple, safe and portable manner. Java also provides an extensible method to handle internally new data types and protocols. Libsys has a Java client to offer web-based connectivity to Libsys.

6.2.4 Uniform Resource Characteristics or Metadata in Digital Libraries

Uniform Resource Characteristics (URC) or meta data, as more popularly known, provides meta data or meta information about an object, and is analogous to bibliographic records. In other words, meta data is information about information available on the web. The OCLC / NCSA Meta Data workshop in Dubin, Ohio held in 1995 proposed the following core set of elements to appear in URC: Title, Creator, Subject and Keywords, Description, Publisher, Contributor, Date, Resource Type, Format, Resource Identifier, Source, Language, Relation, Coverage and Rights Management.

Increasing size and complexity of the digital information available on the web demands for methods of its organization. Uniform and structured meta information can effectively be employed to achieve this goal. Meta data support efficient and effective organization, access and retrieval of information contents in a digital library. Meta information is used in effective designing of browsing and search interfaces of a digital library. With attributes of a digital objects defined in the meta information, it is a simple task to organize digital objects into predefined categories specified in search / browsing interfaces.

Availability of metadata encoded in digital objects reduce efforts involved in extracting, storing and accessing key terms. Moreover, it facilitates easier and pinpointed access of appropriate information. Techniques have now been developed that support automated extraction of catalogue information, incorporation of annotations about items, developments of templates that permit users to extract their own meta information. The HTML provides tags for embedding metadata information while coding digital objects.

7. Authorizations, Authentication and Access Control

A true digital library not only requires an organized collection of online digitized contents, it also requires that the contents be accessed and distributed as widely as possible to legitimate users around the globe. Distribution does not means just onsite access, it also means allowing access to authenticated members of the subscribing organization regardless of their physical location. The access management and control involve user authentication, i.e. ability of a user to obtain an identity on the network, and authorization, i.e. ability to correlate a user's identity with rights and permissions to use various services. Server-side software are now available that allows a server to be configured to distribute information with or without right management. InterTrust Systems and Kerberos are two software packages uses often for right management. Operating systems also have inbuilt features to handle right management.

Most vendors of online digital contents support password authentication to their products. Many others like ScienceDirect, IEEE, Link Information Services, AIP support IP address authentication as well as password support. However, a few have (i.e, Proquest Direct) adopted technologies that allow secure access to vendor's server from legitimate patrons who are not on an institutional LAN. The use of CGI scripting / proxy servers allow a subscribing institution to authenticate patrons from

its server and then pass them through to the vendors with the assurance that they are infact legitimate costumers irrespective of their log-in location.

8. Web-based Library Services based on Digital Resources

The digital resources and associated technical infrastructure is only a means to generate services keeping its potential users in mind. Like printed resources are used in traditional libraries to generate services by the library staff, the digital resources are used to generate services using software driven web-based interfaces. Computer programs substitute for the intellectually demanding tasks that are traditionally carried out by skilled professionals. Activities that require considerable mental activities, like reference service cataloguing and indexing, seeking information, etc. are performed by computer programs through web-based interface.

Web-based digital resources can potentially support a range of traditional and non-traditional library services. Most of the library services generated using digital resources resemble closely to those generated manually with improvements and modifications to suit the requirements of automated services. However, digital resources have also been used to generate innovative services that did not have a counterpart in manual parlances. These services are:

8.1 Traditional Library Services Modified for the Digital Environment

8.1.1 OPAC to webPAC

Remote access to the Library catalogues was possible only through a telnet connection till recently. The web-based interfaces are now available for most of the integrated library software packages including Libsys. Web sites are increasingly providing links to their webPAC instead of telnet links to their Library OPAC. Exploiting the provisions of hyperlinking that the web provides, various searchable elements of a bibliographic record in a webPAC are hyperlinks to other records in the database. For example, an author is a hyperlink to all records in the database for that author, a series is an hyperlink to all serial title under that series; a keyword for a record is a link to all records in database having that keyword, etc. In effect, a web PAC adds software-based functionality to a conventional OPAC. A user has additional incentives to visit the library web page hosting webPAC. With web-based resources and services in place, many libraries are phasing out their dumb terminals. The library web sites are increasingly becoming a more logical gateway to the catalogue and other web-based library resources. The acceptability of web-based interfaces to the Library OPAC is much greater because web interfaces are familiar to the users with its graphical and navigational interfaces. The users can click comp lex subjects instead of typing them in or remembering complex unix commands.

8.1.2 CD ROM to Web-based Indexes and Databases

Availability of CD ROM in late 1980s, as a media with high storage capacity, longitivity, and ease of transportation triggered production of several CD ROM information products which were earlier available through online vendors or as conventional abstracting and indexing services in printed format. Some of the important secondary services including “Guide to Current Periodical Literature” (H.W. Wilson) discontinued their print version in favour of CD ROM version which had improved functionality in terms of search and browsing interfaces. The libraries

are witnessing yet another migration from bibliographic databases on CD ROM to web-based bibliographic databases akin to the one that was witnessed earlier from print based secondary services to CD ROM databases. This phenomenon has further been fuelled with availability of web-interfaces for most of the online search search services. The web-based interfaces provide several advantages to users that are either not possible or not yet available on CD ROM. Most web-based bibliographic databases use hyperlinks and other facilities possible in a web documents including link to the full-text of articles to a publisher's web site. Several bibliographic databases have discontinued their CD ROM version in favour of web-based version. Besides advantages mentioned above, migration to web-based services open-up resources to remote users.

8.1.3 From Manual Reference Service to Digital Reference Service

Reference service and imparting instructural training to the library users are key areas of activities for any library. The technology now allows reference librarians to reach out to the users using the network instead of waiting at the reference desk for users to come by. Besides, imparting instructions on mechanisms of using a library, a reference librarian is also involved in delivering reference service that require deep intellectual understanding of subject. Although automated libraries are not yet sufficiently advanced to offer interactive reference services, electronically-mediated reference services are increasingly available through libraries and information centres.

Digital reference service, also called "Ask-An-Expert" or "Ask-A-Librarian" services are Internet-based question and answer service that connect users with individuals who possess specialized subject knowledge and skill in conducting precision searches (Davis, 2000). As opposed to static web pages, digital reference services use the Internet to place people in contact with people who can answer specific question and instruct users on developing certain skills. The people who serve as digital reference experts (also called volunteers or mentors) are most of the time information specialists, affiliated to various libraries.

8.1.3.1. How does it Work

Most "Ask-a-Librarian" services have a web-based question submission form or an e-mail address or both. Users may submit questions by using either form. Once a question is read by a service, it is assigned to an individual expert for answering. An expert responds to the question with factual information and or a list of information resources. The response is either sent to the user's e-mail account or is posted on the web so that the user can access it after a certain period of time. Many services have informative web sites that include archives of questions and answers and a set of FAQs. Users are usually encouraged to browse archives and FAQs before submitting a question in case sufficient information already exists.

Virtual Reference Desk (http://www.vrd.org/) provides resources and links to experts that offer digital reference services. The site hosts searchable database of high quality "ASK-A" service along with alphabetical and subject wise listing. Virtual Reference Desk also hosts a listserv called "Dig-Ref" to promote and explore the growing area of digital reference services.

8.1.4 From Manual Reference Service to Real time Digital Reference Service: Library Chat Rooms

Several libraries have started experimenting with offering real time digital reference service, using chat software, live interactive communication activities, call counter management software, web contact software, bulletin board services, interactive customer assistance system or related technologies.

Many libraries are experimenting with Internet chat technology as an innovative method to extend and enhance traditional and remote reference service. While digital reference service is asynchronous method of information delivery, the Internet chat providing the benefit of synchronous communication between a user and a reference librarian (or mentor). Interactive reference services facilitate a user to talk to a real, live reference librarian at any time of day or night from any where in the world. Unlike with email reference, the librarian can perform a reference interview of a sort by seeking clarifications from the user. The librarian can conduct Internet searches and push websites onto the patron's browser, and can receive immediate feedback from the patron as to whether his or her question has been answered to his satisfaction. Most libraries currently involved in real-time reference service are part of a collaborative network so that they can share staffing and work around the clock to truly provide reference service any time. Library of Congress Collaborative Digital Reference Service (http://www.loc.gov/rr/digref/cdrshome.html) is one of such services. Several institutions including Cornell University, Internet Public Library, Michigan State University, North Carolina University are offering Internet chat-based service using software like LivePerson, AOL Instant Messenger, Conference Room and Netscape Chat. The librarians have observed that their relatively new chat-based service logged significantly more questions in a relatively short time than did their well established e-mail digital reference service.

LiveRef(sm) (http://www.public.iastate.edu/~CYBERSTACKS/LiveRef.htm) maintains an online registry of real-time digital reference services.

8.1.5 From Manual Document Delivery to Electronic Delivery Services

Abstracting and indexing services have proved themselves as most effective means of finding recent and retrospective published research work. The effectiveness of these secondary services are further enhanced with availability of these secondary services on CD ROM with efficient search interfaces and other features that are possible only in electronic media.

Once a researcher gets bibliographic references relevant to his research work, the more arduous task of locating the full-text of research article begins. While the parent library may cater only to 10 - 20 % of his references, remaining articles may have to be arranged through Inter Library Loan (ILL) or through Document Delivery Services (DDS) which can be very time consuming. Most Library use commercial (Informatics India) and non-commercial (BLLD and INSDOC) document delivery services to ensure quick and efficient access to primary information for the library users. Most online search services like DIALOG, ESA /IRS and STN have been offering manual document supply services since their inception. The process is labour-intensive and time consuming.

The term "electronic document delivery systems" implies delivery of electronic version of a document that might involve reproduction of an electronic copy of a document if it is not already available in electronic format. The libraries had been using fax machines for immediate delivering photocopies of articles via telephone lines. The first use of electronic document delivery was based on scanning technology. With maturity of scanning equipment and technology, document supply services started scanning the documents as bitmap page images. Applications are built in such a way so as to automatically produce a hard copy together with a header page containing the address of the applicant which can again be send by snail mail or facsimile. A software package known as "Ariel" is used in several libraries in developed countries for delivery of scanned articles via the Internet. The Ariel software is loaded on an Internet-enabled computer, can receive and send electronic information to other libraries which have installed Ariel. The ADONIS system developed in late 1980s is a document delivery system based on bit-mapped page images.

Availability of most of the peer reviewed research journals in electronic format, inexpensive technology to scan articles and improved electronic delivery mechanisms are some of the enabling factors that has contributed to well-established electronic document delivery system now available commercially. More recently most of the secondary services that were available on CD ROM or through online search services are now available on the Internet where the journals are linked to the publisher's site. The technology has now been perfected and there are several electronic document delivery services that allow a user to download an article in full-text from their site or deliver them electronically as attachment to e-mails. Most electronic publishers and aggregators like OCLC, Blackwell, OVID, etc. are offering document full-text of articles through their web sites. Different vendors have various payment options; some charge each time the journal is used, whereas others provide open access for a set annual fee. A user who wishes to have the item delivered can enter a credit card number and specify a delivery method (postal, UPS, fax, e mail, etc.) and indicate whether it is a rush item (with a rush order fee attached.)

Some of the important Electronic Document Delivery Services include:

Uncover	http://uncweb.carl.org/uncover/subtitle.html
Articles in Physics	http://ojps.aip.org/
Bioline Publications	http://bioline.bdt.org.br/journals
BioMedNet	http://biomednet.com/library/
Chemport	http://www.chemport.org/
ScienceDirect	http://www.scienceDirect.com/
OCLC	www.oclc.org/
Northern Light	www.northernlight.com/

8.2 New Web-based Library Services

8.2.1 Virtual Library Tours

Several library web sites facilitate virtual guide to the physical facilities including collections, services and infrastructure available in the library through their

web sites. The combination of the following three web-based interfaces are used to facilitate the virtual library tours:

8.2.1.1 Library Maps and Floor plans

Most library web sites provide library layouts and floor plans to guide users to physical location of facilities and services alo ng with link to relevant information. Client-side image maps are used to make various parts of floor plans as clickable image maps. An example can be seen at the Central Library Home Page of the Central Library, IIT Delhi at **:** http://www.iitd.ac.in/library/info/layout.html.

8.2.1.2 Library Departments/Units/Services/Facilities

All physical facilities are listed through selection boxes linked to the library floor plans along with relevant description.

8.2.1.3 Photographic Views

A view of 360° photographic environment using plug-ins like Quick Time and iPix are available at a few library sites. Examples can be seen at Botsford General Hospital Library site. (http://www.botsfordlibrary.org/tour.html).

8.2.2 Library Web Sites

Academic libraries in developed countries started using web technology to create home pages as starting points or as gateways for searching information about the library. A home page reflects characteristics of an academic institution. It provides an opportunity to the library to propagate its services and facilities to the academic community worldwide. The home pages of libraries are increasingly used as an integrated interface designed to deliver detailed information about a library as well as to provide access to all computer-based services offered by a library.

Besides offering information, the library web sites of academic institutions invariably hosts subject gateways or subject portals that contains links to web resources for subjects of interest to the institution. Most of the services (modified or new) included in this article are offered through the web sites of most of the academic institutions especially in developed world. The IIT Delhi Central Library also offers several of these services through its web site available at http://www.iitd.ac.in/library/. The Sun-site Digital library at University of California at Berkley (http://sunsite.berkley.edu/libweb/index/html) lists more than 4,000 libraries having web sites.

8.2.3 Subject Gateways or Library Portals

The web, being a hypermedia-based system, allow linking amongst electro nic resources stored on servers dispersed geographically on distant locations. The portal sites or gateways redirect a user to the holders of the original digital material. The librarians, being the earliest inhabitants on the web, and following their professional instincts, immediately began to create link to collections on all sorts of subjects.

A subject gateway can be defined as facility that allow easier access to web-based resources in a defined subject area. The simplest types of subject gateways are sets of web pages containing list of links to resources. Some gateways index their lists of links and provide a simple search facility. More advanced gateways offer a

much-enhanced service via a system consisting of a resource database and various indexes, which can be searched and / or browse throughout a web-based interface (O'Leary, M., 2000).

Subject gateways are also known as Subject-based Information Gateways (SBIGs), subject-based gateways, subject index gateways, virtual libraries, clearing houses, subject trees, pathfinders and other variants thereof. Subject gateway is an important component of a library web site designed for the library users so as to help them discover high-quality information on the Internet in a quick and effective way.

In the traditional information environment human intermediaries, such as publishers and librarians, filter and process information so that users can search catalogues and indexes of organized knowledge as opposed to raw data and information. Subject gateways work on the same principle, i.e. they employ subject experts and information professionals to select, classify and catalogue Internet resources to aid search and retrieval for the users. Users are offered access to a database of Internet resources descriptions which they can search by keywords or browse by subject area. A description of each resource is provided to help users assess very quickly its origin, content and nature, enabling them to decide if it is worth investigating them further. In the process users get benefited from the expertise of librarians and subject experts with subject gateways rather than having to locate, evaluate, filter and organize the resources themselves. Specialized software are available as freeware or as priced software to create and maintain professionally developed subject gateways. Some of the major portal sites or gateways that provide access to electronic resources on the Internet are as follows:

WWW Virtual Library	*http://www.edoc.com/*
Internet Public Library	*http://www.ipl.org/*
Michigan Electronic Library	*http://mel.lib.mi.us/*
Penn Electronic Library	*http://www.library.upenn.edu/resources/*
BUBL Information Service	*http://bubl.ac.uk/*
Argus Clearing House	*http://www.clearinghouse.net/*
Internet Index	*http://sunsite.berkeley.edu/InternetIndex/*

8.2.4 Web-based User Education

The www provides a dynamic environment for distributing information over a large network and web-based instructions is a suitable tool to do so. Web-based guides and teaching tools can be easily updated, accessed, and printed on demand. They may include colour graphics, and screenshots. The web-based user education provides a high degree of interactivity and flexibility to the users offering them the benefit of self-pace, graduated to teach from basic to highly advanced levels and designed in a wide range of formats that accommodate diverse learning styles. The proliferation of digital resources will generate greater demands on reference and instructional services. With availability of digital resources that can be used any where at any time, requirement for instructional and reference services would also grow. Failure to develop both the technological aspects and required service components would lead to under utilization of digital resources. The library web sites can use web-based user education for imparting training to users in the following area:

i) Basic library skills along with glossary of library terms;

ii) Using Library OPAC / webPAC, locating books, magazines and other library materials;

iii) Instructions for searching CD ROM and web-based databases and other electronic resources; and

iv) Instructions on subject searching training, using Boolean operators and searching Internet resources through search engines.

The web technology provides for incorporating both synchronous and asynchronous interactivity in the web-based user education.

8.2.5 Frequently Asked Questions (FAQ)

Most library web sites have Frequently Asked Questions (FAQ) along with their answers. Some libraries have database-driven FAQs along with search interface. These FAQs are generally on the services and facilities that the library provides. These FAQ generally do not include reference questions.

8.2.6 Library Calendar

The library calendar lists events or show information for forthcoming events. Library calendars have improved look and functionality with JavaScript or special software.

8.2.7 Web Forms

Most library web sites have web forms for inviting feedback from the users such as:

i) Suggestions for services;
ii) Users Survey;
iii) Comments on the web site and suggestions to improve it;
iv) Requests for library to acquire certain titles or materials;
v) Reference Service (often Ask-a-Librarian); and
vi) Interlibrary loan or other document delivering services

8.2.8 Bulletin Boards, Threaded Discussion Forum and Listservs

Several libraries are using bulletin boards, threaded discussion forum and listservs to help promote and evolve web-based library services. Most libraries use bulletin board system as an electronic message system to propagate or announce the services and new activities. The bulletin board system is also used as an interactive interface to invite suggestions on activities and services of a given library. It can also be used as an interface to distribute library services. Messages in a bulletin board system can be written by any one and are stored in a common area for any one to read.

Discussion forum allow open exchange of messages on a topic of common interest. Discussion forum allow users to initiate a discussion on new topic, replying to an ongoing discussions (called thread). All messages for a given topic or thread are grouped together for the convenience of users. Discussion forums are basically modified bulletin boards, which have added feature of dividing messages into logical

groupings called thread. Threads enable a person to focus on a particular topic and see input from many individuals making comments on the topic.

A listserv is a mailing list program wherein a group of people with common interest are connected by e-mail. Any mail sent to the listserv is distributed to all those who have signed up for the list. Several libraries host listservs for the users for providing them a platform to discuss and share their views on books that they have read, or discuss specific books / authors.

9. Conclusion

Rapid growth of the Internet and associated technologies, in particular the WWW, has opened up an entirely new medium for providing improved information services and resources for the users. As information professionals, we have the opportunity not only to play a leading role in the organization and navigation using new tools and technologies such as metadata and web mining, but also in the development and maintenance of web-based services and resources for our users and organizations. However, with availability of web-based resources and services, the local collection of a library is not the only source of information for a user. The users are interacting virtually with the library collections and resources as well as with host of resources that the librarian did not select or may not even know about them. The librarians can no longer stay behind the desk to wait for the users to come, assuming that the users would approach at the right time and for the right things. The role of library as a primary aggregator of content for its user is less and less unique. In an environment of self-service databases, electronic forms, web information and the growth of distance education, a user is likely to approach the librarian after he has already begun his search, but was not satisfied with the results.

The future will require the librarians to reorient themselves, think creatively and adopt the new technology to generate services and resources where their skills of structuring and organizing resources are put to its best use. With myriad of disorganized and unverified information, the web is in need of librarians who are trained in the structuring and organizing information, have the ability to locate and evaluate information resources, and have in-depth subject expertise. If the librarians are committed to sustain their roles as providers and facilitator of information in the emerging and competitive space of higher education, they would need to adopt new technology, interact with users to learn about their requirements and expectations. The ground rules are changing, but the value of libraries and librarians to the academics and the society is enduring. The librarians have to join the learning community as coaches and collaborators, guide the students through the complex maze of print and digital resources, teaching them how to search effectively and helping them judge the quality and usefulness of the information that they encounter. The opportunities are limitless especially in the chaotic scenario of Internet.

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