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Electronic Information Resources

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2.1 INTRODUCTION

Resource sharing in the sense of sharing printed documents is largely based on scarcity of financial resources, which resulted in reductions in the range and depth of information resources individual libraries can make available. Traditional co-operative projects do not offer a real solution to the problem of deteriorating collections. The changes being experienced in the transition to a digital environment offers new opportunities for co-operative action in making information available to users. Information in electronic formats is one of the major contributing factors that foster library consortia.

The proliferation of electronic information services and products, and increasing availability of information processing, storage and communication technologies in libraries facilitated the sharing of resources and engendered new cooperative schemes. The availability of networked information resources encouraged libraries to streamline their cooperative collection development efforts. Possessing electronic information resources does not prohibit other libraries' access to information. This has facilitated cooperative collection development efforts and further encouraged libraries to set up library consortia to provide more and varied electronic resources through the networks and to increase their bargaining power with publishers of electronic information resources (Tonta, 2001).

In a traditional resource sharing arrangements sometimes encouraged competition rather than cooperation in view of the benefits that relatively large libraries accrued by owning research materials. This is no longer the case, however. Small libraries can get access to information sources over the network with the same speed as the large ones can, regardless of where the physical sources are held. Furthermore, introduction of new pricing models by publishers such as licensing (rather than subscription) and access fees for electronic information sources and relatively favorable offers for consortia agreements has made the economics of cooperation more visible.
One of the important characteristics of electronic information resources is that by its very nature of being electronic makes the information accessible and sharable regardless of time and space. While there are considerable efforts in creating comprehensive digital libraries across the globe, it can be safely said that there is not a digital library without a print library. What we have today is more like a “hybrid library”. Corcoran, M (2003) in his overview of the hybrid library, defines it as the library that contains mix of print and electronic resources, offered in a variety of formats and delivered either locally or remotely. It is neither a traditional, print-based library nor is it fully digital it exists on a continuum somewhere between the two. He believes that the hybrid library is a very real model in and of itself will continue to exist as a very real working model for a number reasons including:

- Libraries have made huge investments in print resources; these legacy resources are likely to remain outside the e-domain.
- Even where decisions are taken to digitize legacy materials, this is an expensive and labour intensive activity. Furthermore permissions to digitize are not readily granted.
- Despite rapid technological developments, the technologies to truly deliver digital libraries are not yet available. We are still operating in a changing environment with transient and immature technologies.
- Until publishers/suppliers can guarantee access to archived electronic journals, libraries will continue to rely on a hybrid journal collection development policy.

As a corollary to the last statement, even if there is a guaranteed access to archived electronic resources, print counterparts cannot be dumped away. So, hybrid library is here to stay. Of course, the scope of the hybrid library will include more and more digital resources. And what we discuss below is the other half (or even more) of the hybrid library, i.e., digital library. It can be safely declared that there will not be a library without digital components in its information collections.

2.2 DIGITAL LIBRARIES
The term "electronic information resources" is used in a wider perspective to include all sources where the information is available in electronic formats and accessible with the help of computers. These sources include automated library, electronic library, virtual library, paperless library, networked library, library without walls, and multimedia library and all of them are used interchangeably and synonymously. The term digital library has however become the preferred term due to growing interest and marries the missions, techniques, and cultures of physical libraries with the capabilities and cultures of computing and telecommunications. The advantages of digital information are well established and understood - it can be delivered direct to the user; multiple simultaneous use is possible with no degradation from use and with minimal storage costs; sophisticated searching techniques are available and retrieval is fast.

According to Koch, T (2000), the term "Digital library" is abused for almost all *single* areas mentioned below:

- Collection
  - Licenses to documents/databases/services owned by others (format, standards, policy, economic, consortia, competition)
  - Digitizing own collections (format, migration, image vs. text)
  - Electronic publishing (support, rules, format, standards, conversion, guarantee authenticity)
  - New types of documents, born digital (metadata, border of a document, what to index)

- Access
  - Virtual access
  - Technology, net, computer
  - Archives and preservation of digital documents
  - Copyright, payments, authentication, security
  - Resource sharing
  - Delivery

- Discovery and retrieval
  - DESIRE model for discovery and retrieval
• Metadata and cataloguing
• OPACs and discovery centers
• Knowledge organization and representation (classification, indexing, subject access etc.)
• Integration between digital and physical collections (Hybrid libraries)

- Mediation
  • User interface: tailor made, coordination, visualisation
  • Education: user-, distance-, staff-
  • Support, hot-lines
  • Electronic reference service
  • Literature search service, online, Internet, intelligent personal agents, SDI, etc.
  • Role of the librarian, decentralized work

The term "digital library" has come to refer to any aspect of text, image or sound, as it exists in digital form as opposed to a traditional format. Digital information presently exists in a variety of formats: OPACs, library networks, CD-ROMs, local databases, online commercial databases, gopher space, the World Wide Web, image libraries, audio libraries, digital video libraries and so forth (Lynch and Garcia-Molina, 1995).

2.3 DEFINITION OF DIGITAL LIBRARIES

Defining the digital library is an interesting, but somewhat daunting, task. There is no shortage of proposed definitions. One would think that there would be some commonly accepted and fairly straightforward standard definition, but there does not appear to be. Rather, there are many. And one common thread among all these definitions is a heavy emphasis on resources and an apparent lack of emphasis on librarians and the services they provide.

A review of digital libraries literature, written by scholars from a wide array of fields including LIS and computer science, reveals that even in the professional environment a large number of definitions are in use. In literature, the digital library may also be called
the library without walls, virtual library, electronic library, e-library, desktop library, online library, future library, library of the future, logical library, networked library, hybrid library, gateway library, extended library or information superhighway. Of these many terms, digital library, virtual library, electronic library and hybrid library are most common.

D. Kaye Gapen's comprehensive definition of a virtual library (Saunders, 1996) mirrored many elements of ARL's digital library definition:

The virtual library has been defined as the concept of remote access to the contents and services of libraries and other information resources, combining an on-site collection of current and heavily used materials in both print and electronic form, with an electronic network which provides access to, and delivery from, external worldwide library and commercial information and knowledge sources. In essence the user is provided the effect of a library which is a synergy created by bringing together technologically the resources of many, many libraries and information resources.

The electronic library, however, is somewhat a different notion:

The electronic library will be realized as an aggregation of catalogs, lists, and indexes of documents of every imaginable type, organized according to myriad schemes of classification, and linked and cross-indexed for search, so that they come to behave as a single database in which the lines between individual collections and catalogs are blurred. (Nunberg, 1993)

According to Mel Collier (Collier, 1997), the electronic library is:

managed environment of multimedia materials in digital form, designed for the benefit of its user population, structured to facilitate access to its contents and equipped with aids to navigation of the global network
In more understandable terms, digital libraries would ideally be able to store data at multiple sites and allow a user to search for information across these multiple repositories in a single step.

Collier (1997) says that a library becomes digital when the majority of its resources are held in electronic form.

Sun Microsystems (2002) defines a digital library as the electronic extension of functions users typically perform and the resources they access in a traditional library. These information resources can be translated into digital form, stored in multimedia repositories, and made available through Web-based services. The emergence of the digital library mirrors the growth of e-learning (or distance learning) as the virtual alternative to traditional school attendance. As the student population increasingly turns to off-campus alternatives for lifelong learning, the library must evolve to fit this new educational paradigm or become obsolete as students search for other ways to conveniently locate information resources anywhere, any time.

The Association of Research Libraries has defined a digital library as follows (ARL, 1997):

*There are many definitions of a "digital library." Terms such as "electronic library" and "virtual library" are often used synonymously. The elements that have been identified as common to these definitions are: The digital library is not a single entity; the digital library requires technology to link the resources of many; the linkages between the many digital libraries and information services are transparent to the end users; universal access to digital libraries and information services is a goal; digital library collections are not limited to document surrogates: they extend to digital artifacts that cannot be represented or distributed.*

ACM defined digital libraries as follows (Fox 1995):
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The phrase "digital library" evokes a different impression in each reader. To some, it simply suggests computerization of traditional libraries. To others, who have studied library science, it calls for carrying out of the functions of libraries in a new way, encompassing new types of information resources; new approaches to acquisition (especially with more sharing and subscription services); new methods of storage and preservation; new approaches to classification and cataloging, new modes of interaction with and for patrons; more reliance on electronic systems and networks; and dramatic shifts in intellectual, organizational, and economic practices. To many computer professionals, a digital library is simply a distributed text-based information system, a collection of distributed information services, or a networked multimedia information system. It may have materials that are mostly from outside and organization, that are generally of high value, and that have had special electronic services add to its quality during creation, collection, organization, and/or use. To modern day users of the WWW it suggests more of the same, with sure-to-come improvements in performance, organization, functionality, and usability...Those studying collaboration technologies see digital libraries as the space in which people communicate, share and produce new knowledge and knowledge products. Those working on education technology see digital libraries as support for learning, whether formal or informal.

Digital Library Federation defines (Walters, 1998):

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.
This definition involves three key components, which constitute the theoretical framework underlying digital libraries, namely:

- people;
- information resources; and
- technology.

Cleveland (Cleveland, 1998) provides some working definition. Digital libraries are libraries with the same purposes, functions, and goals as traditional libraries—collection development and management, subject analysis, index creation, provision of access, reference work, and preservation.

But the definition by Ram and others (Ram, et al, 1999) comes very closer to the subject of this thesis. They define a digital library as a networked system environment that provides diverse user communities with coherent, seamless and transparent access to large, organized and digitized information resources.

However, what do all these definitions of the "digital library" have in common? An emphasis on technology and information resources and a very noticeable lack of discussion of the service aspects of the digital library and there is no reference to the role of the librarian in the digital library. That is where the library consortia have a role to play. Library consortia not only bring together the technology and resources but the human – the librarians as well.

2.4 HISTORY, TRENDS AND GROWTH

Libraries have gone through several generations of technology as they have evolved from print to electronic resources. Libraries are responding to the challenges of new technologies by taking the opportunity to redefine their fundamental role in the creation, distribution and provision of access to information.
Digital libraries have a short yet turbulent and explosive history. A number of early visionaries, such as Licklider (1965), had a notion of libraries in the future being highly innovative and different in structure, processing, and access through heavy applications of technology. But, besides visionary and futuristic discussions and highly scattered research and developmental experimentation, nothing much happened in the next two decades. By the end of the 1980s, digital libraries (under various names) were barely a part of the landscape of librarianship, information science, or computer science. But just a decade later, by the end of the 1990s, research, practical developments, and general interest in digital libraries exploded globally. The 1990s brought a revolution that made possible the extension of the automated library to a more enhance electronic library or digital library. The accelerated growth of numerous and highly varied efforts related to digital libraries continues unabated in the 2000s.

2.4.1 GLOBAL TRENDS IN ELECTRONIC INFORMATION

Libraries of all types and in all settings are developing a global vision of international networked collections and services. This model views libraries as both providers of worldwide knowledge resources and gateways for users to knowledge, which is increasingly electronic in form. This transformation requires recognition of important revolutionary changes, which are transforming collections, information services and the working relationships among libraries (Neal, 1999):

- the personal computing revolution is at the core of individualized technology and the expanding power to access, analyze and control information
- the electronic revolution is producing vast amounts of digital information in all media and intelligent software that enables effective search and retrieval
- the network revolution is creating a vast telecommunications web and robust platforms for distributing an expanding volume of electronic resources
- the push revolution is shifting radically the nature of network searching by narrow casting automatically to users through customized packaging and delivery of information
the self-service revolution is encouraging fundamental rethinking of user services in an environment where user initiated and controlled activities are becoming commonplace

the partnership revolution is promoting higher levels of cooperation and collaboration among organizations as a fundamental requirement for success and as a basis for consortia co-investment in electronic information

the authorship revolution is defining the facility and the creativity potential of the network where anyone with a minimal investment can post information to millions of potential readers on a global scale

the intellectual property revolution is threatening fair use rights for digital information and creating extraordinary conflict between the interests of information providers and information consumers

the digital preservation revolution is energizing concern about the integrity and archiving for future use of the vast amount of electronic information being produced and lost

the information as commodity revolution is increasingly viewing data and its synthesized products, knowledge, as articles of commerce and sources of profit rather than property held in common for societal good

the knowledge management revolution is spawning a new relationship among researcher, librarian and information technologist which maximizes the usefulness of data gathering and information generation

These trends illustrate dramatic new directions in the nature and role of library collections and services. In the early 1970s, libraries began to adopt software applications to allow them to perform specific functions more efficiently. The next phase of library automation combined several library activities into one integrated system, allowing librarians to perform almost all their functions online. Data entered once could be used in multiple ways, which increased efficiency and accuracy. The transition from large scale computing technologies to microcomputers was well under way by the mid-1980s. This trend required re-education of the library and systems IT staff, which added significant cost to libraries. Three changes followed: different library application providers, more
powerful technologies, and software applications and networking configurations that were no longer developed in-house. Libraries of all types began utilizing new application systems to automate resource sharing. Union Catalogs and Inter-Library Loan modules were developed by library software vendors to allow cooperating institutions to combine their catalogs and allow patrons of one library to request and borrow materials from linked institutions.

As the 1980s ended, libraries and computing centers were tackling communications, relational databases, and information distribution challenges. The 1990s saw greater use of campus communication infrastructures and commercial communication systems to create and store information and then to deliver it from libraries to end-users.

Large databases from periodical, magazine, and journal publishers became increasingly available in digital format — at first on CD-ROM; later via online services. Library services are transitioning from local traditional collections to global resources provided on demand via the most advanced networking technologies. Today, library collections are used by people on campus as well as by individuals who are not even located on the library's physical facilities. Thus, individuals associated with a given institution and accessing resources from afar need new electronic interface tools. As a result, professional librarians must be computer literate and knowledgeable about Internet technologies to fully participate in the planning, design, and implementation of future library services.

There is general agreement that much of the early actual application of computers to information retrieval was stimulated by the prominent scientist Vannevar Bush (1945), who wrote about the "memex," a mechanical device based on microfilm technology that anticipated the ideas of both hypertext and personal information retrieval systems. The first real-world applications of computers to libraries began in the early 1950s with IBM and punched card applications to library technical services operations, and with the development of the MARC (machine-readable cataloging) standard for digitizing and communicating library catalog information. J. C. R. Licklider (1965) coined the phrase
"library of the future" to refer to his vision of a fully computer-based library, and ten years later, F.W. Lancaster (1978) wrote of the soon-to-come "paperless library." About the same time Nelson (1974) invented and named hypertext and hyperspace. He also analyzed some of the problems to be identified later in this paper in some detail, but never built an operational system. Many other terms have been coined to refer to the concept of a digitized library, including "electronic library," "virtual library," "library without walls," "bionic library," and others.

All these advancements in technology have fostered the growth of library consortia and the extension of offerings beyond the organizational boundaries of individual libraries.

2.4.2 GROWTH OF ELECTRONIC KNOWLEDGE RESOURCES

Although information in electronic format was created with the advent of the computer in the 1950s, it was not until the early 1960s that the first database suitable for searching was developed. MEDLARS was the first on-demand computer-based information retrieval service, and it was developed primarily for the medical profession. In 1971, MEDLINE, the online version of MEDLARS, was the first major online dial-up database search service. In the following year, DIALOG offered the first public online commercial database. With these first databases, there were no real acquisition decisions, as they were offered as access services to which libraries could subscribe. Actual searching of these databases produced charges that many libraries passed along to users. While the information revolution was clearly underway, it was not until after the introduction of the CD-ROM in the mid-1980s that electronic resources began to have a major impact on selection practices in libraries.

Many of the first CD-ROM products offered to libraries were versions of larger online databases and were supplied on a subscription basis with ownership of the data remaining with the publisher/producer. Initially, the price of the product included licensing of the content and possibly the purchase of a computer and CD-ROM player as well. Products were guaranteed to work only with specified CD-ROM players, as standards were not yet established. The purchase of this equipment as part of the cost of the information product was not always easy. Often equipment was not considered an appropriate use of the
library's materials budget. However, equipment budgets were not always large enough or flexible enough, initially, to accommodate this new demand. As with audiovisual materials, the unit price of these products was high and use was often limited to one individual at a time.

Although very expensive at first, CD-ROM products gradually became more affordable. As personal computers became widely available in most libraries, these products also became very popular. Initially, only one person could use these CD-ROM databases at a time, a major drawback, especially considering their high cost. The alternative was to purchase the needed database on magnetic tape and mount it on the local computer system, which could provide simultaneous access to many users. This, however, was a very expensive solution and one that most libraries could not afford. Gradually, hardware and software solutions were found that allowed several users to access the same CD-ROM database simultaneously. Some libraries even found ways to provide access to CD-ROM products to sites outside of the library.

The World Wide Web permeates almost all aspects of computing. An ever-increasing array of information producers now relies on this media to distribute their products and services. But while the Web continues to grow at an incredible pace, the need for workgroup-level CD-ROM sharing continues. There continue to be a very large number of titles that cannot be accessed via the Web, and there was no indication that all information will be distributed in this media. Today, there are many proprietary information sources published on the CD-ROM that are not available on the Web. Until many security and authentication issues find better technical solutions, many publishers have been continuing to use media such as CD-ROM and DVD to distribute their products. One of the critical issues regarding the use of the Web involves allocation of bandwidth. Most organizations have limits on their Internet connectivity and must make decisions on what resources will be accessed locally and which will be used remotely via the Internet. To conserve bandwidth, it makes sense to rely on the local network for the most heavily used resources, even when both access options are available. The ability to access multimedia from a CD-ROM shared on a local network offers tremendous performance advantages over loading that same information via the Internet. Consider
that even a single speed CD-ROM offers roughly twice the data throughput capabilities of a 56kbps modem. For applications rich with multimedia content or where performance is particularly sensitive, then the ability to access that information on a local network can be an important benefit. Most organizations will need a variety of access options.

Given the dominance of the Internet and the Web, the organization's local network followed an Intranet design. In an Intranet, the World Wide Web serves as the primary model for computing, and the Web browser acts as the primary tool for accessing resources, both local and remote. This trend toward the Intranet model of computing makes it critical for a CD-ROM server to be well integrated into the Web environment.

The developments in electronic information, development of networked access and delivery of new library services has seen a radical transformation in the information chain (Fig. 2.1):
2.4.3 RECENT TRENDS IN ELECTRONIC INFORMATION IN INDIA

As a prerequisite for sharing electronic information in the modern library consortia environment in India, it is important to look at the change in trends with regard to content availability in multiple formats, storage technology, computer technology, communication technology, Internet technology, content delivery policies and practices which will give an idea about the digital climate in the country.
CD-ROMs came to India somewhere in mid 80’s. It was the time when CD Drives were supplied, installed and maintained by information vendors and not the computer vendors. Medline CD-ROMs were the early entrants in the Indian libraries. Large number installations of CD Drives were from Hitachi and Toshiba and Silver Platter, one of the largest CD-ROM publishers at that time had major share of subscriptions to CD-ROM databases such as Medline, ERIC, etc. The CD Drives were installed on a stand alone DOS based operating system and only one user can access the CD. The CD contained mainly indexing and abstracting information in a text format. During 1990’s CD-ROM networking came into existence. CD-Net systems from Meridian Data Inc had led the way by more number of installations. However, due to the fact that installation of local area network is prerequisite for the CD-Net and the cost of establishing both LAN and CD-Net were too expensive for the libraries to bear, the CD-Net installations have not grown much.

Later, an image based CD-ROMs (eg. Social Science Full text, from Proquest/UMI) along with GUI based search program came into existence. But these image based CD databases ran into several hundred of CDs and the access was primarily a single user as there were no hardware to support mounting of all the CDs and provide access. That is when Network attached storage (NAS) and CD-Jute box came. Users could swap CD’s in and out of the jukebox to make them available on the network. However, electronic journals available through internet using web browser have effected a paradigm shift in terms of access to information. Following pages describe the developments in India(Pandian and Karisiddappa, 2004):

YEAR 1998:

- Very few ISPs (Government managed)
  ERNET, NIC, VSNL

- Low bandwidth and unreliable internet connectivity (9.6kbps)
ERNET was able to provide only 9.6 kbps connectivity through VSAT though the subscription charged was for a 64kbps connectivity. VSNL was providing Internet connectivity through leased lines or radio link, but these were managed in most of the cities by Department of Telecom – the basic telephone service provider, as VSNL did not have a node. The leased lines were primarily copper wires and getting optical fibre cable (OFC) connection was very expensive.

- Costs of internet connectivity were high
  A 64kbps connectivity cost about Rs. 13-14 lakhs including one time cost for equipments and infrastructure facilities.

- Most of the online products did not have support of archive / backups. One needs to be a continued subscriber to ensure the access

- Storage technology was predominantly CD based

- CD based information products were many and the investments in infrastructure to host all of these were very high

- No set of Auditing procedures for online information products

YEAR 1999:

- Telecommunication reform
  TRAI was setup by Government of India to regulate telecom related policies and issues.
  - Bandwidth improved
  - Reliability improved
  - Costs remained higher
  - Storage technology improved (higher storage hard disks at lower prices)
  - DVD products
  - CD still dominated
  - Improvements in content delivery policies
    - free access to archives for the period of which subscription paid or little extra costs
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- electronic archive in CD/DVD
- More Digital initiatives by publishers, commercial vendors and libraries

**YEAR 2000**
- More ISPs (Satyam, AIRTEL)
- More bandwidth and reliable connectivity
- Less connectivity costs (costs of 64kbps=2mbps)
- More Internet based information sources
- Cost effective digital archives (JSTOR)

**YEAR 2001**
- IT Bill
- Online source has become part of the library collection
- More sources in JSTOR like systems available with special developing countries low prices (US$ 1000 for business collection)
- Library Consortia Initiatives (IIM Library Consortium, CSIR Consortium)

**YEAR 2002**
- More online journals on the publishers' web site with lot more improved web enabled search interfaces. Library Consortia activities expanded (INDEST, UGC INFONET, etc)

**YEAR 2003**
- Digital library activities.

**YEAR 2004**
- More digital library activities (Universal Digital library at IISc) and a few more.
- More consortia based access to electronic resources
2.5 CHARACTERISTICS OF DIGITAL LIBRARY

One of the early authors on the electronic library was Kenneth Dowlin who wrote a book entitled "The Electronic Library" in 1984. He defined the characteristics of the electronic library as follows (Dowlin, 1984):

- Management of resources with a computer
- The ability to link the information provider with the information seeker via electronic channels
- The ability for staff to intervene in the electronic transaction when requested by the information seeker
- The ability to store, organize, and transmit information to the information seeker via electronic channels

While there is considerable uncertainty about what the digital library means, it can be contrasted with conventional libraries in important respects. Differing from the traditional library, Digital library has its own characteristics and functions that are the direction of the traditional library. It can be generalized into the following aspects (Baohua et al., 2002):

- The digitalization of the information resources
  It is the basis of the Digital library and the other characteristics are based on the digitalization of the information resources. Digital is the basis of the information and the information lives on the digital. This is the biggest difference between digital library and traditional library.

- The internet of the information transfer
  On the basis of the digitalization of the Informational resources, the digital library has contracted the world libraries with innumerable computer and Internet system. It also bridges cross-time Information service, opens the Information use and standardizes the information transfer.
The share of the information
Because of the solid foundation of the digitalization and Internet, this aspect of the digital library embodies cross-district, cross-industry limitless resource and service and embodies cross-district cross-country cooperation of resource setting up together and convenient of the resource of the sharing. The traditional library cannot compare with it.

The knowledge of information supply
The digital library has been realizing changing document offering into knowledge offering differ from the traditional library. Form analysis, recombine information, it can offer the knowledge to readers requirement or help readers find the way to solve the question, and the information offering will be met from several times to one time.

The fictitious information object
The digital library has connected the objective library with the fictitious library, and on the base of the objective library, it tends to the virtual library. In the digital library, the objective library has close relation with the fictitious library. The objective library is the foundation, and the virtual library is the direction.

Digital libraries are a distributed network system environment since many different types of information resources will be interlinked together to provide user with value added services. In this context, digital library is not a single entity (Ram et al, 1999).

Digital library:

- has an open architecture built on collection of distributed information resources
- stores multiple formats
- contains both metadata and data
- provides integrated functions of searching and presenting
allows seamless and transparent access to multiple heterogeneous information resources
facilitates interoperability
provides user friendly easy to use interfaces and query facilities
and serves users both information seekers and providers

Chowdhury CG and Chowdhury S (2003) have identified the following characteristics of digital libraries:

- Variety of digital information resources
- Digital libraries reduce the need for physical space
- Users at remote
- Users may build their own personal collections by the facilities provided by the digital library
- Provides access to distributed information resources
- Many at the same time can share same information
- Paradigm shift both in use and ownership
- Collection development be posed on potential usefulness and appropriate filtering mechanisms be followed to negotiate the problem of plenty
- Ability to handle multilingual content
- Presupposes the absence of human intermediaries
- Should provide better searching and retrieval facilities
- Digital information can be used and viewed differently by different people
- Digital library breaks the time, space and language barriers

Mel Collier (Collier, 1997) provides the following characteristics of digital libraries:

- Access to the digital library is not bounded in space or time. It can be accessed from anywhere at any time.
- Content in electronic form will steadily increase and content in printed form will decrease
Content is in textual, image, and sound form

Usage of electronic information as a proportion of total usage will steadily increase, and usage of printed material as a proportion of total usage will decrease

Expenditure on electronic material will steadily increase and, relatively, expenditure on printed material will decrease

Expenditure on information will shift from ownership to subscription and licensing

Expenditure on equipment and infrastructure will increase

Usage of buildings will shift from stockholding to places for study, animation and citizenship

Jobs, training and recruitment will be re-profiled

2.6 DIGITAL LIBRARY DEVELOPMENT

Building a digital library is expensive and resource-intensive. Before embarking on such a venture, it is important to consider some basic principles (McCray and Gallagher, 2001) underlying the design, implementation, and maintenance of any digital library:

- Expect change
- Know your content
- Involve the right people
- Design usable systems
- Ensure open access
- Be(a)ware of data rights
- Automate whenever possible
- Adopt and adhere to standards
- Ensure quality
- Be concerned about persistence

A digital library, however, should be more than a digitized one. It should be built according to principles that are not necessarily the same as those employed for paper
collections, and it should be evaluated according to different measures, which are not yet totally clear.

A digital library collection may include two types of information resource. One type comprises the “digital original” resources, which are sometimes referred to as resources, which are “born digitally”. The other type comprises “digital surrogates”, which are created from traditional information resources through format conversion.

There are essentially three methods of building digital collections:

- digitization, converting paper and other media in existing collections to digital form
- acquisition of original digital works created by publishers and scholars. Example items would be electronic books, journals, and datasets.
- access to external materials not held in-house by providing pointers to Web sites, other library collections, or publishers' servers.

The following items declare the underlying beliefs and expectations regarding digitization (Washington State Library Council, 1999):

- Creation of digital files makes economic sense for reasons of creating access, not for reasons of preservation of collections. Digitization can create more rather than less demand to use the original documents.
- The digitization pilot projects will be conducted using only documents that are in the public domain or have clear copyright and permissions documentation.
- Adherence to national and international standards and guidelines will be promoted.
- Collaboration among library organizations proposing digitization projects will be promoted.
- It is important to create methodologies useful to libraries for each phase of a digitization project: acquisition and organization of documents; preparation of documents; indexing and description of documents; scanning of documents;
creation of delivery formats; public access of documents; storage/archiving of documents.

- Content and access costs should be considered separately from digitization charges.

2.7 DIGITAL LIBRARY AND TECHNOLOGY

Technology has revolutionized the concept of libraries. The advent of the computer has revolutionized the ways conventional libraries are organized and operated. Networking and computing technologies have now become sufficiently advanced to support the design and deployment of large digital libraries which are not only capable of supporting the conventional end-user functions, but also networked access to printed and non-printed materials, including images as well as audio and video files.

Because of the "digital" nature, information resources can be shared over the powerful network. With the innovative use of information technology and the integration of many tools and techniques developed thus far and in the foreseeable future, information provision can be more complete, faster, and broad-based. They can be accessed anywhere anytime by anyone who needs them. Thus, the potential should be great.

The development of the digital library (DL) requires the following technologies (Mukaiyama, 1997):

- Contents processing technology
  
  Technology that provides effective creation, storage, and retrieval of primary information and secondary information: including digital conversion from conventional, non-digital media.

- Information access technology
  
  Technology that enables efficient accesses to myriad types of information without time or location limitations.
Human-friendly, intelligent interface

User interface that brings, to diverse users, increased intellectual productivity and an improvement to the active cultural environment.

Interoperability

Technology to make interoperable works possible in heterogeneous environments.

Scalability

Technology that enables DL systems to handle increases in information and users.

Open system development

Development using international and de facto standards, without loss of performance.

Highly flexible system development

Technology that can adjust quickly to new information and related changes to social systems.

2.8 DIGITAL LIBRARY ENVIRONMENT

ARL (1992) through a major studies identified series of different activities considered essential to the formation of digital libraries (Von Wahlde and Schiller, 1993). These included:

- Use of, or development of electronic document delivery services;
- Policies, services, or reallocations that emphasize access [to information] over ownership;
- Participation in cooperative development or purchase of electronic files;
- Participation in the development of a campus-wide information system;
A written plan that states its goal as access to information from a single workstation;

Enhancement of the online public access catalogue (OPAC) to include the holdings of other libraries besides those held locally;

Providing a gateway from the OPAC to other databases or networks, such as the Internet;

End-user access to online files from on or off campus;

Connection with the Internet;

Training faculty and students:
  o in the use of Internet sources; and,
  o in end-user searching;

Subscribing to electronic journals;

Digitization of text for electronic storage, retrieval and/or dissemination;

An e-mail front-end that allows users to initiate interlibrary loan and delivery requests, suggest purchases, or ask reference questions from within the OPAC; and,

Access to electronic full-text.

Amanda Magnussen (Magnussen, 2003) has grouped these activities into the following categories (table 2.1):
### Table 2.1: Digital Library Environment

| The Internet and Intranets | □ Development of library internet and/or intranet sites  
|                          | □ Internet Connection  
| Integrated access to resources | □ Single workstation access to resources  
|                          | □ Use of OPAC as a gateway  
|                          | □ Inclusion of external holdings on local OPAC  
| Digitisation of materials | □ Digitisation projects  
| Electronic publications | □ Electronic Journals  
|                          | □ Electronic Full-text  
| Electronic document delivery | □ Commercial and library-to-library electronic document delivery  
| Resource Sharing | □ Access to resources over ownership  
| Cooperative activities | □ Cooperative purchasing or development of resources  
| End-User services | □ End-user access to online resources  
|                          | □ Internet training for clients  
|                          | □ Searching training for clients  
|                          | □ End-user electronic requesting  

The above activities may provide a conceptual framework for "functional and operational" digital libraries. In order to have more "functional" and "operational" digital libraries, we need to do much more by integrating technology, content and users. The Report of the DELOS-NSF Working Group on Digital Imagery for Significant Cultural and Historical Materials provided a conceptual framework for digital libraries as follows (Chen, and Kieman, 2002):
This conceptual model attempts to illustrate the relationships among people, content, and technologies in developing research agenda.

2.8.1 DIGITIZATION

The term "digitization" refers to the electronic process of converting a document in a non-digital medium into digital form for storage, retrieval and transmission. Although digitization is an important first step in making materials available, it should be ascertained that the need for digitization exists within a user community and that the digitization efforts will actually be able to serve that community. Surveying existing technologies and practices of digitization can only lead to the conclusion that prudence and a certain amount of conservatism in choosing projects and technologies should be encouraged.

2.8.2 DIGITAL LIBRARY COMPONENTS
As shown in the following figure (fig. 2.3), a fully developed digital library environment involves the following elements (Sun Microsystems, 2002):

- Initial conversion of content from physical to digital form.
- The extraction or creation of metadata or indexing information describing the content to facilitate searching and discovery, as well as administrative and structural metadata to assist in object viewing, management, and preservation.
- Storage of digital content and metadata in an appropriate multimedia repository. The repository will include rights management capabilities to enforce intellectual property rights, if required. E-commerce functionality may also be present if needed to handle accounting and billing.
- Client services for the browser, including repository querying and workflow.
- Content delivery via file transfer or streaming media.
- Patron access through a browser or dedicated client.
- A private or public network.

![Functional Components of a Digital Library](image_url)
A digital library includes five component parts (Dennis):

- the host computer system - or server - where data is stored;
- system and application software that facilitates the organization, searching, display and maintenance of the digital objects;
- end-user desk top workstation where the digital collections are displayed and manipulated;
- the network that delivers digital objects from the host server to the end-user; and
- the creation and conversion of data.

It is the interactions of these component parts which determine the success of a digital library implementation.

2.9 DIGITAL LIBRARY ACCESS SYSTEM

A digital Library access system is defined as "anything which gets digital content to the user or the user to the content." The digital library framework permits many different computer systems to coexist. The key components are shown in the figure below. They run on a variety of computer systems connected by a computer network, such as the Internet (Arms, 1997).

![Diagram of Major System Components of digital library](Adapted from Arms, William Y, 1997)
The Digital Library (DL) system should satisfy the access, browsing, search storage, rights management, and publishing needs of a broad range of users. Each group will have different needs and use the system in different ways. The DL system should be flexible enough to accommodate the different knowledge bases of each group of users as they seek to use the system. In addition, the system must provide sufficient management tools for library staff to maintain the quality and integrity of the information resources and administer the system on a daily basis. It should seamlessly integrate all library information resources.

2.10 DIGITAL LIBRARY AND PEOPLE

While a good deal of the literature on digital libraries emphasizes technology and resources at the expense of the service perspective, a number of authors and researchers have considered human interaction in the digital library environment. A number of studies at Lancaster University (Twidale, 1995, 1996; Twidale & Paice, 1996; Twidale, and Paice, 1997) have considered the importance of human interaction in the digital library. These studies focus on the social interactions of library users with librarians, librarians with librarians, and users with other users. By studying these collaborations in physical library settings, the authors have drawn some general conclusions that might be applied to digital library design:

- Collaboration between users, and between users and system personnel, is a significant element of searching in current information systems.
- The development of electronic libraries threatens existing forms of collaboration but also offers opportunities for new forms of collaboration.
- The sharing of both the search product and the search process are important for collaborative activities (including the education of searchers).
- There exists great potential for improving search effectiveness through the re-use of previous searches; this is one mechanism for adding value to existing databases.
- Browsing is not restricted to browsing for inanimate objects; browsing for people is also possible and could be a valuable source of information.
Searchers of databases need externalized help to reduce their cognitive load during the search process. This can be provided both by traditional paper-based technology and through computerized systems (Twidale et al., 1996).

In a paper presented at the Digital Libraries '94 Conference, Ackerman (1994) stresses that, while the concept of the digital library "includes solving many of the technical and logistical issues in current libraries and information seeking," it would be a mistake to consider solely the mechanical aspects of the library while ignoring the "useful social interactions in information seeking." Ackerman outlines four ways in which social interaction can be helpful in the information-seeking process:

- One may need to consult another person in order to know what to know (help in selecting information).
- One may need to consult a person to obtain information that is transitory in nature and as such is unindexed (seeking informal information).
- One may need to consult others for assistance in obtaining/understanding information that is highly contextual in nature rather than merely obtaining the information in a textual format (information seekers often have highly specific needs and interests).
- Libraries serve important social functions, e.g., students and/or faculty meeting each other in hallways, study areas, etc. (socializing function).

Ackerman notes that these points all argue for the inclusion of some form of social interaction within the digital library. Such interaction should include not only librarians, but other users as well.

In a paper for the Digital Libraries '96 Conference, Brewer et al (1996) argue that intermediary services should play a crucial and essential role in the ongoing development of digital libraries so as not to limit the digital library to the role of "passive warehousing. The authors identify three major purposes for intermediation in the digital library environment:
Interaction with potential information beneficiaries.
Interaction with information resources.
Mediation between information resources and users to add value during the information transfer process. (Value added services could include "searching, categorization, filtering, translation, publishing, or some combinations of these activities.")

While the authors do not focus solely on human intermediaries (indeed, a great deal of the discussion focuses on software intermediaries), they do make a very strong case for the necessity of intermediaries in the digital library environment and call into question the notion of a digital library as a passive warehouse. Noting that intermediation services "will be crucial to the development of effective digital libraries," the authors establish the importance of value-added services to the digital library.

Matson and Bonski (1997) discuss the development of the National Drug Intelligence Center within the U.S. Department of Justice. Based on these experiences, they outline three roles that have been proposed for the librarian in the digital age:

- the librarian as enhanced service provider in a proactive manner;
- the librarian as guru of copyright, licensing, and electronic redistribution—i.e., the understanding of what users and organizations actually want to do with information; and
- the librarian as system interface designer, making use of experience with how library users request, use, and process information.

Abbas (1997) summarizes a number of roles that others have identified for future librarians:

- librarians as gateways to the future and to the past;
- librarians as teachers;
- librarians as knowledge managers/workers;


2.11 DIGITAL LIBRARY AND COLLABORATION

It is critical that digital libraries provide access to valuable, interesting content and assist users in selecting, evaluating, and utilizing resources, no matter what their format. Collections and expertise are the two invaluable additions we offer to the networked world. We must collaborate to optimize the technological opportunities before us. Creating true digital libraries, not just digital collections, will require librarians to work closely together.

Digital library contributors will need to collaborate in their efforts to digitize resources if they are to be successful and distinguish themselves from digitization projects, which have stood alone inside individual institutions or organizations. Several collaborative planning efforts are underway. These efforts are allowing participants to become more familiar with the formidable technical challenges facing them. They also prompt them to work together across lines, institutions, and professions to (Kranich, 2003):

- create a mutual vision for a common future;
- share expertise and rich collections;
- build upon earlier models of cooperative activities such as preservation, interlibrary loan, and collection development;
- reduce redundancy and the waste of acquiring or converting materials more than once;
- leverage scarce financial resources;
more comprehensive planning;  
measures that assess user impact;  
additional levels of communication;  
new kinds of authority structures with dispersed leadership;  
shared and mutual control;  
pooled or jointly secured resources; and  
shared products.

As a result, collaboration to create digital libraries will need:

new organizational frameworks;  
serious commitments by library leaders and their organizations;  
equal risk taking across all organizations;  
continuous evaluation and assessment of progress;  
brokering of relationships and entrepreneurial activities; and  
a flexible, creative, responsive learning environment.

2.12 DIGITAL LIBRARY AND ECONOMICS

The availability and management of information in digital formats has opened up varied means of fast and portable 24/7 access, encouraged new research routes, refreshed the information consumer-base and redefined the public domain, among other obvious benefits. The Economic properties of Digital libraries are (Hayes, 1997):

Cheaply Shareable

Digital libraries are easily and cheaply transportable and shareable. The first copy is likely to represent most of the costs, with costs for reproduction and distribution relatively minor. As a result, the number of copies that can be produced without serious depletion of physical resources is great.
\begin{itemize}
  \item Value Increases with Accumulation

  The value of a digital library increases at more than a linear rate as it grows. This is perhaps one of the most distinctive and important features of a digital library as a resource. As it grows and when it is combined with other digital libraries, it may be transformed, new relationships developed, and new insights gained as a result of the inter-connections. As a result, indeed the value of an accumulation of digital libraries is far more than the total of the individual values.

  \item Self-Generating

  Digital libraries are expandable and self-generating. This is especially important because virtually an unlimited amount of intellectual goods can be created, and digital libraries have exponentially increased the ability to do so.

  \item Costs Independent of Scale of Application

  The cost of digital libraries is independent of the scale of application. Economists use the phrase "indivisible in use" to mean that, and digital libraries indeed are indivisible, so there are immense economies of scale. Putting this together with the value in accumulation provides strong incentives for large-scale users to acquire digital libraries. For the same reason, there is efficiency for shared rather than independent accumulation. As a result, joint consumption is likely because it is inefficient to exclude or withhold service from those who don't pay. This may well be the most significant contribution of the World Wide Web, as a digital library source.
\end{itemize}

The short and long term effects of digital libraries will affect the users either indirectly, directly, or both. The potential economic value of digital libraries will be quantitative and qualitative. The qualitative value refers to the additions or subtractions to the users'
quality of life due to the addition of a new product. While this may be difficult to measure before digital libraries are implemented on a large scale, quantitative costs are easier to estimate before the fact. Certain elements will be incorporated into the cost of digital libraries such as the costs of publishing, acquisition of materials, hardware, software, and trained staff at the physical library. Library budgets can account for some of the monetary costs, but especially for the initial investments required for such a venture, they cannot cover all the expenses (Friend, 1995).

Simon Tanner (Tanner, 2003) in his editorial says that the effective utilization of resources is among the most important of management activities and in the context of digital libraries has several components:

- immediate start-up costs of either creating or purchasing digital content;
- further implementation costs for establishing a digital library or even just basic access to bought resources;
- costs implicit in preserving, managing and maintaining a digital resource in the longer term.

The publishing costs are a source of major controversy. Under the current publishing system each copy has a monetary value attached to it, but in the electronic environment multiple copies can be made with little effort and no paper trail. The ease in making multiple copies, whether electronic or printed, of electronic works complicates the issue of fair use. The disagreement lies mainly among publishers, librarians, and database vendors. Another source of disagreement is how to charge for the use of information and who gets charged. Libraries and schools prefer a flat rate because it is budgetable while publishers and database vendors want a variable rate (like long distance calling or pay-per-view) to be in force so they can make money similar to how they do now.

To investigate the issue of value in depth, it is useful to re-evaluate the purpose of a library. Rangarathan (1931) provides the basis for library purpose as:

- Books are for use
- Every reader his book
Every book its reader
Save the time of the reader
The library is a growing organization.

Reflecting on this fundamental statement of library theory in an electronic environment, Gorman & Crawford (1995) suggest that it is a valid basis for the assessment of digital libraries. To take this further, the concept of value can be seen from the perspective of the 'reader', or user, in the ability to locate and use that material which is relevant to their information need. This suggests that the streams of digital library research into usability, performance of virtual communities, new scholarly communication models and information seeking behaviour are a part of establishing an assessment of value. If the new uses of information provided an insight into value, perhaps the more fundamental issue arises of not just how information is found, but also the level of availability of relevant digital collections for the reader (Missingham, 2003).

Collections comprise many types of material, such as journals, monographs, conference papers, theses, original materials (such as manuscripts, pictures) and maps. For research and scholarly communication, the major resource documents have traditionally been journals in the scientific disciplines and a more even mix of journals, monographs and conference papers in the humanities. All of these resources are now in digital and print forms, to varying degrees.

To apply Ranganathan's principles to this situation, the reader would be optimally served by the library which enabled access to the required or relevant resources. Ranganathan's third principle would be met when the library enabled the relevant resources to be available, whether known to users or not. To put this in the perspective of value, the digital library creates value when the collections, needs of users and information production are in synchronization or harmony. A lack of value would occur where the overlap between these three aspects is minimized.
In examining the cost effectiveness of electronic resources, White and Crawford (1998) confirm that expenses are not always reduced when new services are offered; they may just be shifted elsewhere in the budget. New services may increase customer expectations, and intangible benefits should be considered, such as the immediacy of full text versus the time lapse for ILL. These trade-offs—increased costs versus increased access—must be addressed by each library, time and again.

2.13 DIGITAL LIBRARY ISSUES

Just as the literature identifies a number of activities that together make up digital libraries, so too does it show that the development of digital libraries is heavily dependent on a number of inter-related enabling (or hindering) factors.

Harter, Stephen P (1997). has identified the following problems and issues related to information resources in the digital library:

- How can we establish and control the currency, accuracy, and integrity of information sources (quality problem)?
- What can be done to provide intellectual access to IRs? (Organizational problem)
- How can we maintain the data and intellectual integrity of IRs? (authority control problem)
- How can we recognize different versions of the same IR? (fluidity problem)
- How can we establish object surrogates, metadata, and corresponding fine-grained search tools so that we can find those objects that we are seeking?
- How can we address the issue of transient IRs? (preservation problem)
- How can we preserve the concept of authorship?
- How can copyright laws for IRs be observed? (legal problem)
- Will access to some IRs be limited to some classes of users? (political problem)
- What services, if any, should be offered by the digital library?
Should digital libraries be integrated into traditional libraries? If so, how can this be accomplished?

Does a digital library have librarians? If so, what do they do?

Does a digital library have well-defined classes of users?

Who will have access to which services, and at what price? Will our digital libraries of the future only be for the use of the "haves?"

Amanda Magnussen (Magnussen, 2003) has grouped the above into the following categories of issues in the digital library environment:

Legal issues
- copyright
- contracts
- privacy

Financial issues
- financial resources
- changes to funding allocation

Client issues
- client needs
- client attitudes
- resistance to introduction of new technologies

Personnel issues
- staff commitment to new systems and services
- changed staff training and competencies
- effect of automation on staff skilling and
- professionalisation

Organizational issues
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- need for new organizational structures
- reorganization of hierarchies and work divisions
- organizational size
- balance between professional and
- paraprofessional staff
- appropriate position levels

- Management issues
  - strategic planning
  - need for new or different performance measures
  - organizational support and leadership
  - need for champions within the organization
  - appropriate statistical measurement

- Technological issues
  - security
  - infrastructure development
  - use of appropriate technologies
  - standards

- Collaboration issues
  - resource sharing
  - cooperative purchasing of information resources
  - cooperative purchase or development of
  - hardware and infrastructure

- Subject discipline issues
  - availability of content for different disciplines
  - appropriateness of delivery method
2.14 CONCLUSION

A digital library is less about its collection than it is about its ability to be opportunistic. In a time when information is much cheaper to produce and transport, every effort will be made to take advantage of increased access to information. Similarly, the increased computing power that can be brought to bear on information stores such as data mining will be employed for a variety of purposes, subject to the needs of a digital library and an information community. Given the model of the role of digital libraries in information communities presented in this document, a digital library may achieve what Ranganathan called a growing organism. But through its activities, a digital library may also become a "learning organism." This ability to learn comes from the technological advancements of the last 40 years, particularly from the coupling of computing and telecommunications technology. Digital libraries are a natural extension of the evolution in which libraries have been involved for centuries. They represent a fundamental leap forward in the provision of services for, and the partnership with, information communities.
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