

DIGITIZED INFORMATION RESOURCES AND NETWORKS IN THE ACADEMIC AND RESEARCH ENVIRONMENT

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0. INTRODUCTION

I am grateful to the organizers of CALIBER-96, the M.S. University of Baroda & the University Grants Commission INFLIBNET Programme, for inviting me to participate in the Third National Convention CALIBER-96 on Library Database Management, and to present the keynote address at the inaugural session.

The INFLIBNET programme is mainly concerned with the networking and sharing of information resources of academic and research centres in India. But in the emerging information environment the programme will be influenced by what is happening in the information field in other sectors in India and, perhaps, more by the developments globally. Therefore, my presentation will touch on the emerging global digital library and network scenario, briefly about the national scene, and mention some priority steps for realising an effective information network.

1. CONVERGENCE OF TECHNOLOGIES

The emerging information technology (IT) is characterized by the convergence and integration of several technologies - computer, telecommunications, electro-optics, audio, video and multi-media. The resulting synergy among the components, wisely used, can give considerable power to the individual to contribute to society's development and welfare. The new IT's reach is vast, in fact, it is global in scope. It can be availed of by the specialized and sophisticated scholar and professional, the politician and the legislator, the decision-maker, the executive, and the manager, the entrepreneur, and the factory worker; and it also can reach out to the semi-literate and illiterate in the rural areas.

2. DIGITAL LIBRARIES: POTENTIAL AND GROWTH

2.1 Emerging Digital Environment

An important product of the application of IT is the rapid growth of digitized information sources and networking among these, and they offer great potential.

Fifty years ago in 1945, Vannevar Bush proposed the development of Memex (short form of 'Memory Extender'), a desk size device to provide linked, global access to multi-media knowledge resources

(As we may think, Atlantic monthly). The technology, expertise and the opportunities exist now to develop systems that will be capable of providing quick and easy access to humanity's store of information, through the emerging networked digital libraries. There are already several digital information access facilities including libraries of different types, such as, computer code libraries, object libraries, image libraries, audio libraries, digital video libraries, libraries of databases, gopherspace, CD-ROMs, the World-Wide Web, OPACS, etc. This trend will continue as the cost of digital storage decreases relative to the cost of library shelf-space, and as digital services become more useful, affordable, available and usable. Other forces influencing the development of digital libraries include electronic publishing, the desire for collaborative work, and the industry push to use the ITs.

2.2. Global Digital Resources

Advances in computers, networking, communications and information access technologies, together with global level inter-connection of computers and computer networks with Internet as the backbone, are making it possible desk top, single window access to computer stored information, both public domain and commercial sources distributed around the world, with new sources being added quite frequently.

Tools for accessing these information sources are also undergoing rapid improvements. Starting with the

provision of basic tools, such as, e-mail, ftp and telnet, Internet has shifted to navigation agents, such as, Wide Area Information Servers and gopher, and to consumer-oriented 'home pages' of the World-Wide Web (WWW) - a system of hypertext links that simplifies navigating among the thousands of offerings on the Internet. Information sources around the world are getting linked through Web pages residing on Web servers spread around the world including India.

Several projects have also been initiated focused on developing digital libraries to provide remote access over the Internet to very large document collections, often with multi-media content, stored on distributed servers. It is unlikely that there will be just one grand World Digital Library; more likely that there will be a number of them, many with specialized collections inter-networked among themselves.

3. ATTRIBUTES OF DIGITAL LIBRARIES

3.1. Better Suited to Support Information Use Patterns

Close observation of how people seek, analyze and use information in relation to their research or when dealing with a problem, i.e. in their workspace, indicates that it will not be appropriate to simply transpose our notions of the use of conventional library resources onto the use of digital library resources. For instance in a real world working situation researchers and others tend to move from one type of source to another (e.g. text to tabulated data, to graphs, pictures, and to audio and video) (cf. a doctor or an engineer), and they also need to communicate with other persons (e.g. peers, or specialists in related or other areas). The emerging ITs are conducive to such information seeking and use patterns, by providing rapid access to remotely located data sources of different types and facility for communicating with others locally, nationally and even globally.

Support for communications and collaboration is as important as supporting information seeking activities as the exploding use of the Internet has shown. Digital library networks can support such a requirement much better than conventional libraries.

3.2. Alternative Approaches Required

Levy and Marshall in a paper *Going digital: a look at assumptions underlying digital libraries* present a work-oriented perspective on libraries and argue that current views of digital libraries are largely derived from an idealization of the traditional library, from our experiences with local and academic libraries. But digital libraries designed based on such experiences

will unnecessarily be restrictive, not true to the real situation and therefore unusable. A proper framework for the design of digital libraries should be derived from a work-oriented approach, which evaluates library collections and technology in relation to the work being done with them. The digital environment enables the handling of both the more permanent records as well as the fast changing, ephemeral information, e.g. listservs/USENET messages, stock market data, manuals, etc. Digital libraries will contain both digital and non-digital information material, for example, paper based, and film-based materials will co-exist with digital sources. In broadening the scope of digital libraries to meet the emerging demands of information use, there needs to be:

1. media integration, to handle hybrid documents (partially digital, partially paper) and other non-digital media,
2. versioning to handle fluid and transient materials, as well as the more permanent materials,
3. tools for collaboration and communication, include tools for shared annotation and the maintenance of local sub-collections of material, etc., and
4. service practice, to develop new work practices and procedures to handle cataloguing and maintenance of digital collections.

4. NETWORKING OF INFORMATION RESOURCES

Networking of information resources does not imply just linking the document and nondocument materials in libraries and information centres, but of networking whole institutions of which the libraries and information centres are components. It implies interconnecting people both within and outside the institutions, with these information sources on the one hand and among people themselves on the other. Information sources are of three types:

- (1) Structured sources, namely, records and databases;
- (2) Partially structured sources, namely, full text, graphics, images and voice; and
- (3) Unstructured and often unrecognized sources, namely, people, their ideas, expertise, knowledge and skills, intuition, traditions and

conventions, culture, attitudes and behavioural characteristics.

The unstructured people sources are much more vast and at times extremely valuable. As Charles Handy points out, the wealth and progress of institutions and societies of the information age of the 21st century will mainly be dependent on the availability of and investment in intellectual property, that is, people who have a variety of knowledge, expertise and skills. ITs facilitate the interlinking of people and thus enable wider access to and use of this intellectual property.

5. DIGITAL LIBRARIES IN THE TEACHING LEARNING ENVIRONMENT

5.1 The Key Roles

Gary Marchionini and Herman Maurer, in their paper The role of digital libraries in teaching and learning, describe how digital libraries are evolving to meet the needs of teaching and learning. Libraries facilitate three types of learning, namely,

- Formal learning which is systematic and guided by instruction, e.g. courses offered in schools and colleges, training on-the-job, all of these being supported by library resources;
- Informal learning, usually directed by the individual and as and when necessary; resource persons, mass media, and public libraries supporting such learning environment;
- Professional learning which is directed by the individual but more focused, such as taking up continuing education courses to improve work-related knowledge and skills, supported by libraries, personal collections and networking with colleagues.

In such an environment, digital libraries will allow teachers and students to use information sources and tools that have been in the past physically and conceptually inaccessible. The key roles of libraries in learning include:

1. Sharing expensive resources (physical and human resources and library and information services);
2. Preserving and organizing artifacts and ideas (cultural role), and
3. Bringing together people and ideas (social role).

In traditional environments, there is lesser integration among the information sources - physical and human - and the supporting technologies. Digital libraries, on the other hand, can integrate technology and information sources to allow remote access, breaking down the physical barriers between resources. They permit teachers and students to take advantage of the wider range of materials accessible and communication with people outside the formal learning environment. This will allow more integration of the different types of learning, and sharing of various types of resources, time and energy, and expertise for mutual benefit.

There already exist several types of information sources typical of the digital library environment that facilitate learning and teaching. These include:

- bibliographical citations and full text databases,
- table of contents of periodicals,
- electronic serials,
- discussions fora,
- preprints,
- technical reports,
- location tools, directories,
- teaching and training materials,
- data archives (software, numeric data, documents),
- library catalogues,
- campus wide information systems,
- companies and organisations, etc.
- scientific data sets, for example, the Earth Observing System and the human genome project,
- textual databases of classical works,
- image collections of artistic exhibits and museums,
- electronic periodicals,
- USENET news groups,
- listservs and mail archives,

- specialized hypermedia corpora, such as, digital encyclopedias and dictionaries,
- bibliographic indexes and directories, and
- electronic search and display tools, such as, WAIS, gopher and the Web.

To summarize the relevance of digital libraries in learning and learning: Digital libraries can

1. play key roles in formal learning settings by providing teachers and learners with knowledge bases in a variety of media,
2. offer more information than most individuals or schools are able to acquire and maintain,
3. be accessible in class rooms and from homes as well as in central library facilities where specialized access, display, and use tools may be shared,
4. enable remote access to rare and unique materials in classrooms and at home,
5. offer greater opportunities for users to deposit as well as use information, thus, students and teachers can easily be publishers and also users in digital libraries, and
6. will support communities of interest and more specialized courses to be offered.

5.2 Scholarly Publishing and Digital Libraries

Academic and research centres and individual authors publish extensively: papers, books, reports, manuals, teaching materials, etc. What are the implications of digital libraries and networks?

What shifts are likely in the roles, responsibilities, services and revenues of the key players? Gio Wiederhold attempts to answer some of these questions in the paper Digital libraries: value and productivity. He notes that with digital technology:

1. Works (books, periodicals, newspapers, audio and video records, and the like) are stored in digital form, and users can use electronic methods to have materials delivered on their desk at the workplace or home, so that users need not physically visit the library, and
2. the material is always copied from the master version of the work in the digital library which implies that the mechanical aspects of printing

and publishing an inventory of books and periodicals could disappear.

Realisation of these innovations will call attention to several issues, for instance, links to digital libraries must be rapid and affordable if everyone is to be given fair access, traffic and distribution of digital resources like complex, multi-media documents and images along the highways. These changes will have wide ranging effects. With electronic publishing and distribution, as soon as the author's fingers have left the computer keys, the material can be accessed on the net. It is now accessible to all those linked to electronic networks, which reach an ever-growing portion of the world's population. Readers gain by having rapid access, and can skip the intermediate services of librarians, editors, indexers and publishers. The facility to connect with authors and their works directly will encourage disintermediation.

Thus, the introduction of digital libraries will severely affect the traditional functions of authorship, editing, publication, critical review, book selling, libraries, readers and customers. Wiederhold examines these changes in some detail. Some of the links may disappear or survive with drastic re-adjustments and several new services and technologies may emerge, for instance online revenue collection, image search, and dynamic books.

6. INDIANET

6.1. Network of Networks

Already there are several networking initiatives at the national level in India - INFLIBNET, and the regional networks for Delhi, Calcutta, Madras, Bangalore, Bombay, Hyderabad, etc.; NICNET, ERNET, banks network, stock exchanges network, and others. They can provide e-mail and data and information exchange services and facilitate sharing of resources and work. Audio and video image transmission services such as those of the radio and broadcasting networks are also operational in the country. Eventually, there should be a network just linking these networks, say an INDIANET, an Internet type connect facility for India. This would permit a user, located anywhere in the country, to know quickly what data, information, and services are available from or provided by the large number and variety of inter-linked institutional nodes, where they are located, how, under what conditions and at what cost each of them may be accessed and used and, of course, actual access to and retrieval of the needed information. Various types of user-friendly user-interfaces will be needed for different levels of users. Through this INDIANET, users in India could be linked to information bases and services outside the

country via say the INTERNET. Similarly, information may be accessed within India by users from other countries.

7. BASIC INFRASTRUCTURE ELEMENTS

7.1. Production of Quality Indigenous Data Bases

An important consideration is the type and quality of information and data made available in the databases mounted on the networks

Academic and research centres are among the major information resources- resources of libraries, documentation and information centres, researchers, scientists, technologists, professionals and others of these institutions. Besides creating databases of library catalogues, these centres could individually and as joint projects, create databases of document and non-document materials including theses, teaching and learning materials, microform, and audio/video sources in specialised subject areas, mutually agreed upon, factual data-bases, object-oriented databases, (e.g. genebanks, crystallographic data, environmental data, oceanographic data), directories, and union catalogues, software packages, and user-interface programmes, and make them available on the network.

Most of the databases of the online services abroad are produced by academic and research centres and made available to the online service vendors. But these non-indigenous databases do not cover adequately materials in Indian languages, information on our art and cultural objects, and topics in the social and humanities fields, because of the language and script used, or they may be deemed mainly of local or national interest. A good example of such national/regional effort is LILACS CD-ROM medical literature database of the Latin American region, a frequently distributed product and service resulting from the cooperation among some 57 medical libraries in 17 countries with support from the WHO. Information on and descriptions of indigenous technologies, innovations and the like generated by research, academic centres and other institutions need to be captured and disseminated. They are of potential interest not only in India but elsewhere as well.

There already exist some efforts by NGOs - the HONEY BEE operated by SRISTI in Ahmedabad. Eventually we should be able to trade such data and information with other countries. For, an important feature of an information society is its capacity to trade in information and information products and services.

7.2. Norms and Standards

The exchange and sharing of resources - information,

expertise - if the network participants agree to use widely accepted norms and standards for database structuring, input and display formats, telecommunication and networking protocols

7.3. Rapid Development of Telecom Sector

Efficient telecommunications is an essential component for the development of networks of digitized resources and rapid access to the resources. The developments in the telecom sector in the country during the past couple of years are noteworthy; yet in comparison to the other newly industrializing economies of Asia we have a long way to go.

7.4. India's Information Highways

India's first information highway has been set up by the National Informatics Centre (NIC). The first of such linkway was dedicated to the nation in September 1994. Along with India Government's investment in the Motorola Iridium project, IMMARSAT etc., it is a sure sign that sooner or later, India will have a comprehensive and formal cyber space programme. Commissioning the information highway, the Commerce Minister said it would usher in an era of paperless trade, help exporters and enable India to reap the benefits of trade faster than most other countries. For this to become a reality, India's private sector must play a significant, if not a leadership, role.

The info highway is superimposed on the existing NIC network or NICNET which has some 700 earth stations linking 500 centres. While data on the existing network flows slowly, the info highway can transmit voice, video, data, and multimedia information at a speed of 2.2 million bits per second. It means that a 100-page document can be sent in a mere second. Many more cities will be interconnected and it is expected that 2,000 exporters will be connected to NICNET in 16 months. Plans are to eventually link 70 commercially important cities to the information highway.

India's size, complexity, problems, and opportunities, need many hundreds of such highways. The superset comprising of all such highways will become the Indian Information Superhighway, the INDIANET mentioned earlier.

An attempt to link all information networks in the country into a single information superhighway (ISH) is to be undertaken soon and broadcasting is expected to play a major part in it. A large number of networks are already operating in India and these could be linked together to create the ISH. The ISH will be a network of optical fibre, co-axial, twinwire, microwave link with radio, television and satellite bringing together hundreds of inter-connected and inter-operable networks. It can be used in the field of information applications, software

and data bases, and training people in various fields. All these put together will constitute a national information infrastructure for the ISH.

The broadcasting network is well suited to mobile reception of messages. The use of pagers is steadily growing. According to the and B Ministry sources, ISH will increase productivity by 20-40 percent and create massive job opportunities.

On 18 October 1994, India's first digital link to South East Asia, the Middle East and Western Europe, was commissioned in Bombay. The optical fibre link is a true information superhighway because it can flawlessly and rapidly carry any data type ranging from human voice to moving video images at speeds upto 565 mega bits per second per optical fibre pair. This is the world's longest optical fibre marine highway and the Indian Ocean's first digital highway and directly connects thirteen countries - France, Italy, Algeria, Tunisia, Egypt, Cyprus, Saudi Arabia, Turkey, Djibouti, India, East Asia, Middle East, and Western Europe. This has been linked to similar submarine info highways in the Atlantic and Pacific Oceans. Thus, for the first time there is a submarine global multimedia highway. Various actions are expected to be taken to build footpaths to the information superhighway. This would include the academic and research centres.

India Government's first information highway's main targeted user groups are: exporters, educational, research, and medical institutions. Exporters, for instance, are specially encouraged to use electronic data interchange to communicate with their trading partners in the developed countries.

7.5. Human Resources Development

7.5.1. Technical/ Professional Personnel

A critical component of the information infrastructure is human resources - people with the technical/professional knowledge and skills and management expertise to design, develop, operate, maintain and innovate in the information science and information technology areas. India has a vast pool of talented professionals who should be properly guided, trained and utilized to manage the emerging ITs, the digital resources and networks to provide the right mix of information products and services to meet the needs of users at various levels, in different sectors of the economy. The curriculum, courses, and educational strategies should be reviewed and revised and new offerings provided from time to time so as to meet the changing demands of the market.

7.5.2 Informacy

Another aspect of human resource development is the

sensitization and orientation and enhancing the capabilities of people at all levels to effectively use information and information systems. The future is characterized increased diversity and vastly expanded opportunities for enterprising individuals. Increased use of information and communication technologies in education, research, the workplace, and in homes is foreseen. New types of services and supporting infrastructures will arise. On the other hand the skill level of individuals to use information and the related technologies will determine the pace of development of new services and the market. The issue is how individuals and societies they make up as a whole may take optimum advantage of the opportunities in all walks of life.

As society becomes more and more dependent on information, the abilities to read, write and compute are important, but also need to acquire the capacity to use computers, various media and other

ITs efficiently, understand the implications of enhanced access to a wide range and variety of information. There is considerable promotional hype of ITs by the industry. At certain levels of management executives need also to be able to evaluate what is offered and promised. In such a context, informacy, the synthesis of the skills that individuals must possess to cope with the information age needs serious attention by education authorities, policy and decision makers. I have discussed informacy programmes more elaborately in another paper. To summarize, an informacy programme includes: the development of the motivation, propensity and potential of the individual for seeking, processing and using appropriate information for problem solving, decision making, self-learning, etc.; creating an awareness of the availability of information and information sources to meet different needs and situations; creating an awareness of the availability of various tools and techniques for accessing, searching, and retrieving information; developing the ability to extract, synthesize and repackage information to suit individual needs and convenience; developing communication skills, computer literacy, and improving the ability to use different media for information gathering, dissemination and communication.

Implementation of integrated graded informacy programmes should begin for the child in the lowest classes, in formal and informal settings. The propensity to seek and use information will get strengthened in the higher classes and through college and beyond

An informate individual will need minimal orientation and help to use new information sources, services and facilities. And he/she is likely to perform better in

accessing and using appropriate information, besides being a better communicator and comfortable in using modern ITs, whatever be the career path. Such informacy programmes should be an integral part of the national human resources development efforts, to enable the country to move rapidly and smoothly into the information age of the 21st century and at the same time be nationally and globally competitive.

8. ISSUES AND CHALLENGES

8.1. Intellectual Property Rights

There are several issues that designers of digital libraries and networks need to take note of if the full potential of digital libraries is to be realized. These include:

1. Issues relating to access and intellectual property rights (copyright);
2. Intellectual infrastructures for digital libraries, such as, techniques for using electronic information in teaching and learning, from the view point of teachers and students;
3. Tools for interfacing with digital library for finding, managing, using, and publishing electronic information must be powerful and user-friendly; and
4. Digital libraries must provide a mix of software and people to provide reference assistance and question-answering services.

A major unsettled issue in the emerging networked digital library environments is that of copyright: To what extent the present copyright laws, made mainly for the print medium, are appropriate in the new environment? If they are not suitable, what readjustments and re-definitions have to be made and what new laws have to be framed? How are agents like libraries going to be affected?

How will the publishers, key players in scholarly publishing, respond to the new environment?

Pamela Samuelson addresses some of these issues. The key points of her paper may be summarized as follows:

The present copyright laws try to strike a balance in meeting the need to compensate the author for his/her intellectual effort, revenue generation for the publisher for his investment in printing, marketing and distribution of publications and to provide public access to knowledge through fair use, for example, through libraries. But this balance is upset by the digital, networked environment. She observes that while authors or readers will not disappear in digital networked

environments, the same cannot be said categorically about publishers and libraries. The networks make it easier for authors and readers to interact directly with one another in a network-based distribution system for current research papers through "preprints".

Furthermore, the phenomenal growth of the WWW has not only made self-publishing easier, and has blurred somewhat the distinction between authoring and reading, as linking is an activity that shares some traits of authoring and some of reading. The tools for publishing and for reading are one and the same in this environment. If publishers simply manufacture physical artifacts and ship them around, there would be no need for them in the digital environments, for authors can do all that on the Net just as well quite as readily as the publishers can.

Similarly, if libraries merely exist to provide a physical place to house large collections to which remotely individuals travel for access to them, these institutions too may not be needed in the digital environment. But the more likely scenario, at least for the near future, Samuelson feels, is that the intermediaries like publishers and libraries will continue to exist, but with redefined roles and functions, e.g. the publishers performing such functions as selection of good quality products, editing, producing, refereeing, and promotion, in networked environments and libraries as digital libraries to act as collection building agents, publishers of catalogues and guides, navigation agents, providing user interfaces, etc.

If this be the scenario, how can copyright laws handle cost spreading and distribution, compensation and fair use among all the players involved? A key component of cost spreading in the digital networked environment, will perhaps be based on factors, such as, pay-per-use, site licensing for long term use, etc.

8.2. Privacy and Confidentiality

Information in machine-readable is liable to be manipulated and tampered with relatively more easily. Therefore, individual and corporate privacy and confidentiality of certain types of data and information must be secured and ensured as an increasingly larger number of documents are converted to/produced in digital form.

8.3 Policy, Dependence, Sovereignty

I have discussed national information policy issues, implications of information superhighways to developing countries, information dependence and vulnerability, erosion of sovereignty, etc. in a paper contributed to a symposium on Libraries and the Future.

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