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A Proposal for Action Plan for
Digitization of University Libraries

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1   Introduction

Electronic publishing and information accessing have become easy and convenient mainly because of Internet and the World Wide Web technologies. Most digital libraries were developed in the past by taking up projects based on specific disciplines and then developed into full-fledged digital libraries. The inter-networking communication links, low cost storage solutions, powerful desktops, workstations, servers and multimedia hardware and software technologies are now available for initiating the Digital Library projects in India. Digital Library is also known as Electronic Library or Virtual Library with very little difference.

2   What is a digital library?

There are two possibilities – the library that contains material in digital form and the library that contains digital material. The difference is very subtle but the important point is that a digital library has material stored in a computer system in a form that allows it to be manipulated and delivered, which is otherwise in conventional form not possible. An automated library is not a digital library because of the material in printed form. But a digital library must be automated in some of its essential functions.

3   What is digital material?

Digital material can be taken as computer readable material in general. In this computerized age, information and the medium on which it is recorded can be considered as either digitized or not and computer readability is the important criterion here. The creation of digital information from conventional material is generally a two stage process. First stage is digitization – this is essentially the conversion of the physical medium into a digital representation of that physical medium. For example: scanning a page producing a computer readable (digital) image of the paper within the computer. The computer only recognizes a digital picture of the page. The second stage is to have the computer extract information from the digitized image. For text, it is done by Optical Character Recognition (OCR) software to convert the text image into ASCII format for editing and manipulation of information and to store in textual format.

4   Available technology

Digitizing and converting the images to information are very difficult tasks. The computer hardware and particularly the software that performs these functions are good and practical but less than perfect. Optical scanners have high resolution, but are mechanical devices. They need single sheets of paper, which means photocopying the material first. Now there are efficient book scanners to fill this gap. Optical Character Recognition (OCR) may result in errors, which have to be manually corrected. This is particularly true if the material is old and in mixed languages, faded etc. Even after digitization the problem of searching and finding information is often difficult. The low bandwidth connections, incompatible browsers etc., also add to the problems.

5   Policy for digitization

5.1 Need for digitization

i.   Is the specific collection available only in digital form?
ii. Is it required to deliver this material directly to the users' desktops?
iii. Does the user need to search in a non-conventional way for the material they need?
iv. Which material in the library needs to be digitized?
v.   Are there other sources for searching and retrieving the material that the library needs to digitize?
vi. Is the material unique?
vii. Are the users geographically widespread?

If most of the above questions are answered as 'yes', it is sensible to create a digital library.

5.2 Current library expansion

If the library is expanding, the new material can be obtained in the digital form. If the library is going to be a reference repository, it will reduce the cost on digitization and preservation. Further, it should be seen whether the digitized material is justified in terms of its usage. Is it easy to find the material and in a usable form?

5.3 How valuable is the Library's Information?

If the library is used occasionally but intensively, it is still valuable. The best benefits can be obtained through improved search tools for internal and external information rather than digitizing everything.

5.4 In-house creation of digital library

It may be possible to outsource all or most of the functions of a digital library. Alternatively, it may be possible to buy access to external search and delivery services, which cover most of the library's requirements in the digital era. However, they generally do not have the subject expertise of the in-house staff.

6   Audience

6.1 Necessity for new services or materials

Does the digital library proposal come from the library users or was it at least discussed with the users? The users must accept the efforts of the library to digitize and organize materials. If the management is proposing the digital library, it is important to prove that it is beneficial to the organization and its users.

6.2 Accessing the digital library

Since the digital libraries are held in the computers, it is important to provide best

possible access facilities. Access can be permitted from the user's desk wherever they may be. If the users do not have computers then they should be provided with public access.

7   Reasons

7.1 To expand services

i. Are the digital services being added to expand the existing library services?
ii. Are the services and information sources added to complement the existing services or do new services need to be developed?
iii. Are there resources to expand the new services?
iv. Will providing access and services generate income?
v. If the income is generated the matter of copyright payments and taxes becomes important.

Some libraries have unique collection and promoting the widespread use of them is one common aim. It is true when collection is rare, fragile and expensive. In these cases once the digitization process is completed the original can be sent to the preserved environment. This will promote use of the material to expand the library services.

8   Alternatives

8.1 Continuing the services

If the library is providing good services and the users are happy with whatever is provided then there is need for digitization. But one of the problems is assessing the best use of the materials and services. Sometimes users may not know the alternatives that could be available to them by the library. Introducing a digital library just because it is new technology is wrong. It is important to consider the needs of the users, the resources in the library, the requirements of the organization and the improvements in the overall services.

8.2 Outsourcing

If it is decided that a digital library is needed, the best way to achieve it and run it may be to give that task to another organization. The process of retrospectively digitizing the material from the selected collections is a highly specialized work and need expensive equipment for best results. Since it is done once, contracting for the service may be the most cost-effective way. Once the material has been digitized it is worth considering the costs of making it available for access.

9   Costs

9.1 The initial costs

The initial costs depend mostly on the material to be included in the digital library. The type of material, the degree of digitization and the completeness or resolution of the digitization also affects the cost. Care and attention to fragile material adds to the costs. All the above apply to local material to be digitized. If the material is to be acquired in digital form then it has an obvious cost. Once the material is digitized, it has to be loaded into a suitable library application. This will store the digital material, index it, and add it to the library housekeeping database. Networks and network application servers need to be set up or upgraded. The digital files are large and need a lot of storage space and are slow to transfer across a network. Apart from the above capital expenses are training costs for both library staff and end users. If the services are to be provided outside the organization, then there are costs for licensing, etc.

10   Sources of material

10.1 Internal sources

To digitize all the material generated internally by an organization in full text, the authors can submit an electronic form of the material to the organization. The organization can then digitize its material selectively.

10.2 External sources

The external material may be bought outright, its use may be licensed, and leased etc. Sometime the external material is made available to the library online in the digital form. If the source of material is external to the organization, the copyright and commercial issues of dealing with this material becomes much more complicated than the internal sources.

11   Copyright / intellectual property rights

11.1 Ownership of the material

Having a copy of the material does not mean ownership in terms of copyright laws. There is only one copyright owner even though many copies are made. This is true of computer copies, digitized or physical copies apart from the conventional print form. Further, right to re-distribute material usually is not acquired when a copy of the material is bought. Many allow material for copying for research purpose by individuals, under the fair use clause of the copyright laws. However, making copies for re-sale or re-distribution is a matter that comes under the copyright law.

11.2 Security

Like the physical material, the digital material of the library is valuable. Access to it must be guarded. Security for the digital material should be provided in the form of restricted access to the computers that hold the digital material. Unlike the physical

stock, the digital material must be copied and secured. This protects it from natural disaster, damage and software errors. Access security must be allowed for in the digital library. There is need to evolve a method of authorization for persons to access the digital library. Use of watermarks to the digital material will help in locating the unauthorized copying.

12   Standards, formats, and protocols

These are the rules by which objects are described, their data are stored and the systems communicate. The librarians who are planning to establish digital libraries need to know them to make decisions or ask questions while discussing with the suppliers. Some are international standards and some are national standards, some are industry standards and some are in widespread use. In all these cases, the function is to try to unify the representation, manipulation or transmission of some piece of information so that two or more different systems can understand it in the same way. The standards are the basis of interoperability, portability, modularity and building blocks, etc.

The standards fall into three major areas: material description, user access and system architecture. Under the material description, we need to look at two forms – the abstracted information (Metadata) which constitutes the bibliographic description in a library system. The other form is the material itself. Description standards include SGML and HTML from the web and PDF, etc.

  i.   Bibliographic standards are: MARC, Dublin Core, Metadata, AACR, URL etc.
 ii.   Record structures are: ISO 2709, Extensible Markup Language (XML) and Hypertext Markup Language (HTML)
iii.   Encoding standards are: Unicode, ASCII

There are two methods by which users may access the digital library. One is via a dedicated network and the other is over the public networks. Where public networks are concerned two standards of system access exist in the catalogue area. One is Hypertext Transfer Protocol (HTTP) and File Transfer Protocol (ftp) standard from the web and the other is the Z39.50 standard from the information retrieval and libraries. General-purpose browsers like Internet Explorer and Netscape Navigator are widely available and often free.

System architecture covers specialized servers and majority in client/server architecture distributing the workload across the library's server computer and the user's client computer. The *de facto* networking standard is TCP/IP, which is a standard for Internet traffic. The other issues that need to be looked at include: proprietary solutions, scalability and future possibilities.
The formats that are needed for various material types include:

  i.   Images: .bmp , .tif, .gif, .jpg
 ii.   Animation: .ani, .fli, .flc
iii.   Video: .avi, .mov, .mpg, .qt
 iv.   Audio: .wav, .mid, .snd, .aud

v.   Web pages: .htm, .html, .dhtml, .xml
vi.   Text: .doc, .txt, .rtf, .pdf
vii.   Programs: .com, .exe

13   Scanning and digitization issues

The issues involved in scanning and digitization need to be understood and analyzed for converting the printed text, images, photographs etc., in different formats.

- A scanner does not do anything on its own because it requires a software to capture the image for manipulation such as Photoshop, OCR, Textbridge or Omnipage etc.,
- A scanner produces a digital image of the page. This can be saved as an image file, or in the case of OCR software it can be converted to text and saved in a text format.
- A fast scanner will scan a typical page of text in black & white in about two seconds. A low-end scanner may take about 5-6 seconds. Pictures take longer and color picture take much more depending upon the resolution and the size.
- Much more time in needed for manipulation of the object to be scanned – like turning pages and positioning the page on the scanner, especially when bound volumes are being scanned.
- Manual turning time can be reduced, if a sheet feeder can be used but this would require photocopying first and to feed later in A4 size or smaller. Photocopying the sheets from the bound volumes will be a better option to use the sheet feed. This will reduce the problem of positioning the bound volume every time in a flat-bed scanner.
- A book scanner (face-up) has advantages in reducing the manual handling of bound volume, except turning the pages. It also takes care of the problem of page curvature due to binding. The book scanners are expensive but this one time expenditure can be off set with other facilities it provides – time saving, wear and tear of the volume, if the scanning is for preservation effort.
- OCR conversion is slower than scanning- like at least one minute per page and it varies drastically with the quality of the original (clarity, type, size, typeface, cleanliness etc.). Further an error rate of 5% can be expected that means proof reading is required generally.
- Before scanning, resolution must be considered carefully which is measured in "dpi" (dots per inch) sometimes ppi (pixels per inch). The resolution required depends on the intended use (a photograph to be displayed on the monitor whould require 100 dpi to match the resolution of the screen. For text, greater resolution, may be 300 dpi is necessary because we need contrast in the image for readability or for OCR.
- If image files are only needed with out text conversion, choice of file format needs to be decided. The most useful file formats are: tiff, gif and jpeg. For a single page document including photograph gif or jpeg should be used. An alternative in now available – use of Ariel software, which scans multi-page document and produces a single out put file – a multi part tiff file. This requires a

compatible viewer.
- The process of putting material online from a machine-readable source is much easier – Word document etc. This can be readily converted either into HTML web page or into a PDF format using Adobe Acrobat. This takes less time than scanning and OCR.

14   Training

Because digitization is a complex process good staff training at an early stage is important. Training in project management is valuable for those engaged in digitization projects where many partners and providers are involved in collaborative programs. Training on various issues of digital library to different levels of staff including creating the digital resources and managing them etc., should be a focus.

15   Purpose of a digital library

- To expedite the systematic development of procedures to collect, store, organize, information in digital form.
- To promote efficient delivery of information economically to all the users.
- To encourage co-operative efforts to save and share the investments in research resources, computing and communication networks.
- To strengthen communication and collaboration between and among research, business, government and educational institutions.
- To take leadership role in the generation and dissemination of knowledge in the thrust areas of research.

16   Features of a digital library

- Provide access to very large amount of information resources to the users wherever they are and whenever they need.
- Focus on providing access to primary information apart from the secondary sources.
- Support multimedia content along with the text to make the information more useful and understandable to the users.
- Network accessibility in an Intranet and Internet environment.
- Provide user-friendly interface to enable the users to access information comfortably.
- Provide hypertext links for navigation through the required references.
- Support client-server architecture.
- Support advanced search and retrieval for better output to the users.
- Integration with other digital libraries.

17   Technical issues

- High bandwidth computer networks supporting efficient multimedia document

transfer. The infrastructure is critical in a digital library setup. A fiber optic backbone connecting the computers in the university with at least 2Mb Internet connectivity.

- Open communication protocols (client-server, Z39.50 for IR). This will enable the servers in the network to get connected and query and retrieve data without knowing the environment of the other library.
- Information access tools (browsers, display and search tools). The Netscape Navigator and Internet Explorer etc.
- Meta databases (databases that describe and provide links to other databases). Cataloguing the web resources with description, access, retrieval etc.
- Electronic publishing tools. Necessary for creating the resources to make available on the Net.
- Data compression for data transfer electronically and achieving the digital resources.
- Digital storage devices like CD / DVD media and the large Hard disk storage solutions now available.
- Scanning and conversion technologies. The issues and methods for scanning and OCR technology are critical in converting the printed texts, photographs, audio etc.
- Media integration technology (multimedia) to make the digital resources more powerful in delivering the material integrating the text with multimedia.
- Advanced retrieval, indexing, routing and filtering etc. This is essential as the digital data needs a better controlling mechanism for accurate retrieval from the user end.
- Document description and representation standards (SGML). The standard description and representation in electronic format is essential for network access to the digital resources.
- Inter-operability over the network. Any information stored in any server in any platform should be built for access over the complicated network environment.
- Privacy, authentication and security of information. The information stored needs security and access needs proper authentication. Building firewalls to protect the data from hacking etc.
- Location dependent naming of digital source.

18   University of Hyderabad

The University of Hyderabad, one of the premier institutions of higher learning in the Country is celebrating its Silver Jubilee. We are proud that the Institution has made many strides in the short period of over two decades. The excellent teaching program of the University has been widely acclaimed and the high quality research output has made a mark even at the international level. A recent report from the Directorate of Scientific and Industrial Research (DSIR), Government of India ranked the University of Hyderabad as the first among Indian Universities. While we are happy about our past

but we look forward to scale new heights in the area of higher education and research at the dawn of the new millennium.

The University Library is a central facility to support the research and teaching needs of the University. The Library collection include over 2.63 lakhs volumes of books, back volumes of research journals, theses and dissertations and subscribes around 680 current academic research journals. The Library could achieve the distinction of being the first University Library in India to have fully automated all its housekeeping operations and services including bar-code operations. The library database and the CD-ROM databases are accessible to the users over the Campus-wide LAN (Local Area Network).

The Library card catalogue is replaced with computer terminals for the users to search the database. All the library staff members and Users are trained and they have expertise in their areas of operations. Facilities for INTERNET browsing is made available with 21 PCs placed in the entrance lobby of the library for the Library Users. Library has achieved this level of automation using their own enthusiastic manpower, special funding from the UGC and constant support from the successive Vice-chancellors.

With this expertise, library has undertaken two turnkey projects to computerize the libraries in the twin cities of Hyderabad and Secundarabad by networking the library facilities connecting the academic departments (Dr. B. R. Ambedkar Open University Library and City Central Library). Apart from the above, the library also has another distinction of starting from the year 1998, a highly focused two semester Post-graduate Diploma Program in Library Automation & Networking, which is first of its kind in the Country.

Several dignitaries including Chairperson, UGC, Vice-chancellors of several Universities, Directors of IITs, IIMs, R&D laboratories and professional librarians visited this library and appreciated the automated facilities and services. We could provide technical advice to several libraries in setting up their computerized facilities. Several Private Sector R&D laboratories and companies are enrolled as institutional members and they have been using the library services regularly. Digital Library services will greatly benefit them in accessing the resources from their desktops.

19   Document delivery center

The UGC (University Grants Commission) under the INFLIBNET program selected this library as one of the *six Document Delivery Centers in the country* based on several parameters. Under this project, our library is vested with the responsibility of providing Electronic Document Delivery services to the scientists and researchers. With assistance from UGC under major research project, we could compile a Union List of holdings of 31 major libraries in the twin cities. The data is available for hosting on the Internet for wider access. Under IDPAD project of ICSSR, holdings in the Social Science libraries in the twin cities were carried out and the project is handed over to the ICSSR.

20   Digital information

Emergence of powerful computers, access to electronic media, high-end scanners, OCR, advanced telecommunication systems, audio-visual technology and multimedia have given new possibilities in dealing with the collection, organization and dissemination of vast amounts of digital information. The effort of the computers and communication technology has converted the world into an electronic village.

The digital resources are being built as self-service centers and the Librarians continue to play the role of the information provider. With the stagnant budgetary provisions to the libraries, the role of the library has changed from acquisition of information resources to accessing them wherever and in whatever form they are available. Thus, the libraries have to devote a part of their funds to access electronic resources in the form of OPACs, CD-ROMs, Online databases and Web resources. This will eventually lead to working in a Virtual Library environment.

Vast amounts of electronic information resources are available in the field of Science and Technology for access using reliable communication facilities. The cost of digital resources is likely to go down compared to print-on-paper as large number of users are going to rely on accessing these resources. The present day libraries need to establish themselves as Electronic / Digital Libraries.

21   Action plan

The University Library is in an advantageous position to enter into the era of Digital Library since all the earlier computerized activities are stabilized. The professional staff members are competent to handle digital resources and the users are exposed to the computerized information sources. It is necessary to develop an end-to-end content management approach based on the Distributed Server model. The Digital Library Server acts as both a content repository and as a clearinghouse for all the client requests for access to protected materials. The Server should be capable of simultaneously managing and evaluating a variety of access requests and license agreements for each content item in its repository. The work involved in creating a Digital Library include the following:

- **Creation of necessary infrastructure:** hardware, application software, trained manpower, book scanners, OCR, digital camera, large storage solutions, good network facilities, high bandwidth Internet connectivity, etc.
- **Creating the digital resources** covering the materials generated within the University (faculty publications, theses and dissertations, popular lectures by the experts, University publications, proceedings of the conferences / seminars / conventions / workshops etc., held in the University).
- **Subscription to E-Journals:** Full text access with archival backup media from over the Institution-wide LAN.

- **Online access** to commercial databases: selectively accessing on specific requests from the users.
- Accessing, identifying, processing, **repackaging the Web resources for the local users.**
- To enter into **copyright/intellectual property rights** agreements with publishers and content creators.
- Creating the **Web site** and connecting the **Web resources** and the **internally generated electronic resources** for wider access over the Internet
- Conducting the **Staff & User training** programs

22 Methods of digitization

Methods to be adopted depend on the demand the library faces from the users. This is a critical area where a number of decisions need to be taken involving several issues. The methods include:

i. Selection of material: which documents should be digitized?
ii. Choice of Technology: Which medium and what kind of equipment should be used?
iii. How should the information be represented and how will it be stored?
iv. What will be the access mechanism to make a document available?

The first step is concerned with the printed material, which is already available in the library. The transformation of a traditional document into an electronic document by means of digitizing must always take account of storage and accessibility. Before a title is selected for digitizing it must be determined what advantages the process will bring to the library users.

Digitizing by scanning can mean a reduction of information. The high quality of an image must be assured. Various coding systems can be employed, mainly ASCII, for the texts. The technical requirements for the availability of electronic documents have an impact on investment in equipment and training of personnel. Even though electronic access means greater efficiency and wider geographic ranges, costs should not be underestimated. The problem that is critical is copyright area. It may be good idea to involve the publishers in the project planning at an early stage.

By achieving and making available the printed publications in electronic format the libraries can start building a digital library apart from acquiring the material in digital format. This will help in building a technical infrastructure for the information society, which is depending largely on the print materials. The accessibility and ease of use can be improved substantially through the regulation of storage and access processes. When we have the possibilities for substantial enrichment of content, we should take advantage of the process.

23 Infrastructure needed

- Building block with furniture and fixtures
- Hardware (servers, storage devices, book scanners, CD/DVD writers and digital camera, UPS back up etc.
- Software (OCR, LINUX / SOLARIS, ORACLE, Publishing Software, Search Engines etc.)
- Digital Resources (CD, E- Journals, Scientific & Technical journals like, IEEE, ACM, ACS etc.
- Conversion of materials to digital format with proper licensing agreements
- Miscellaneous expenditure
- High speed INTERNET connectivity on broadband backbone

24   Creation of digital resources

- The Library has already created the bibliographical database of books, serials, theses and dissertations, current and back volumes of periodicals. This facility is open to all the users over the Campus-wide LAN. This is a digital resource (secondary source) of the library materials.
- Library has to focus, selectively, in acquiring the digital resources in CD-ROM, Optical disk and Multimedia formats.
- Library needs high bandwidth Internet connectivity for creating local resources, cataloguing, repackaging Web resources.
- Library should subscribe to electronic journals (full text, secondary sources etc.) and slowly discontinue the print-on-paper subscription wherever possible.
- Library may selectively, based on the user requirements, use online access facilities to access major commercial database providers' sites to download the full text articles to create local digital resources for multiple and unlimited access locally and over the network with appropriate license arrangements.
- The most important aspect of the digital library is creation of local digital content available within the University - about the University, University publications, faculty publications, theses and dissertations, project reports, lectures of visiting experts, conferences / workshops / seminars / convention proceedings and special events etc.

25   Digital Library research activities

Following are major cooperative projects, funding and coordinating agencies and associated activities in digital library research. Many research centers maintain lists of projects, typically authored by staff

Coordinating and funding bodies

➢ *Coalition for Networked Information*
A joint project of the Association of Research Libraries, CAUSE, and EDUCOM: to promote information resources in networked environments.

➢ *Council on Library and Information Resources (CLIR)*
Formed through the merger of the Commission on Preservation and Access and

the Council on Library Resources with the mission to identify and findcollaborative solutions to issues that affect libraries, archives, and their Constituencies.

> ### European Commission
> Science, Research, and Development: The 4th Framework   Programme
> - o   I*M-EUROPE
> - o   General Information

> ### European Research Consortium for Informatics and Mathematics
> A consortium of leading research establishments in Europe that encourages collaborative work among researchers and with industry.

> ### The Internet Engineering Task Force
> The protocol engineering and development arm of the Internet

> ### National Coordination Office for Computing, Information, and Communications
> Supports the Committee on Computing, Information, and Communications (CCIC), which reports to the National Science and Technology Council. R & D *Member agencies:* DARPA, NSF, DOE, NASA, NIH, NSA, NIST, VA, ED, NOAA, EPA, AHCPR

> ### National Endowment for the Humanities
> Supports learning in the humanities with funding for various research and education activities, including preservation.

> ### National Digital Library Federation
> A consortium of fifteen of the nation's largest research libraries and archives that have agreed to cooperate on defining what must be done to assemble Digitized materials for broad public access and to United States heritage and Cultures.

> ### National Historical Publications and Records Commission
> Grant-making affiliate of the National Archives and Records Administration (NARA) whose mission includes "the identification, preservation, and dissemination of essential historical documentation."

> ### World Wide Web Consortium
> Develop common standards for the evolution of the World Wide Web.

USA federally funded cooperative projects

The Digital Libraries Initiative Phase 2. The Digital Libraries Initiative – Phase 2 is an interagency program sponsored by the:

- National Science Foundation (NSF)

- Defense Advanced Research Projects Agency (DARPA)
- National Library of Medicine (NLM)
- Library of Congress (LOC)
- National Endowment for the Humanities (NEH)
- National Aeronautics & Space Administration (NASA)
- Federal Bureau of Investigation (FBI)

In partnership with

- Institute of Museum and Library Services (IMLS)
- Smithsonian Institution (SI)
- National Archives and Records Administration (NARA)

➢ Projects funded to date under DLI2 include the ones listed below. Please see the National Science Foundation web site at (*http://www.dli2.nsf.gov*) and follow the links provided there to see project summaries and descriptions. As more projects are funded, they will be added to the list below:

➢ High-Performance Digital Library Classification Systems:
From Information Retrieval to Knowledge Management of University of Arizona, (*http://ai.bpa.arizona.edu/go/dl/*).

➢ Re-inventing Scholarly Information Dissemination and Use University of California, Berkeley, (*http://elib.cs.berkeley.edu/*)

➢ A Multimedia Digital Library of Folk Literature University of California, Davis, (*http://philo.ucdavis.edu/SEFARAD/*)

➢ Alexandria Digital Earth Prototype University of California, Santa Barbara, (*http://www.alexandria.ucsb.edu/adept/adept.html*)

➢ Informedia II: Auto-Summarization and Visualization Over Multiple Video Documents and Libraries Carnegie Mellon University, (*http://www.informedia.cs.cmu.edu/dli2/*)

➢ Simplifying Interactive Layout and Video Editing and Reuse Carnegie Mellon University, (*http://www.cs.cmu.edu/%7Esilver/#about%20SILVER*)

Digital Library for Human Movement

➢ A Patient Care Digital Library: Personalized Search and Summarization over Multimedia Information Columbia University, (*http://www.cs.columbia.edu/diglib/PERSIVAL/*)

➢ Project Prism at Cornell University: Information Integrity in Digital Libraries Cornell University, (*http://www.prism.cornell.edu/*)

- Digital Analysis and Recognition of Whale Images on a Network (DARWIN) Eckerd College, (*http://pythagoras.eckerd.edu/darwin*)

- An Operational Social Science Digital Data Library HarvardUniversity, (*http://www.thedata.org/*)

- A Distributed Information Filtering System for Digital Libraries Indiana University Indianapolis/Bloomington, (*http://sifter.indiana.edu/*)

- Digital Workflow Management: The Lester S. Levy Digitized Collection of Sheet Music, Phase Two Johns Hopkins University, (*http://levysheetmusic.mse.jhu.edu/*)

- The Digital Athenaeum: New Techniques for Restoring, Searching, and Editing Humanities Collections University of Kentucky, (*http://www.digitalatheneum.org/*)

- Founding a National Gallery of the Spoken Word Michigan State University, (*http://www.ngsw.org/*)

- Tracking Footprints through an Information Space: Leveraging the Document Selections of Expert Problem Solvers Oregon Health Sciences University, (*http://www.cse.ogi.edu/dot/research/footprints/*)

- Data Provenance University of Pennsylvania, (*http://db.cis.upenn.edu/Research/provenance.html*)

- A Software and Data Library for Experiments, Simulations, and Archiving University of South Carolina, (*http://econ.badm.sc.edu/beam/*)
- Stanford Interlib Technologies Stanford University, (*http://www-diglib.stanford.edu/*)

- Image Filtering for Secure Distribution of Medical Information Stanford University, (*http://www-db.stanford.edu/pub/gio/TIHI/TID.html*)

- A Digital Library of Vertebrate Morphology, Using High-Resolution X-ray CT University of Texas at Austin,(*http://www.ctlab.geo.utexas.edu/dmg/index.html*)

- A Digital Library for the Humanities Tufts University, (*http://www.perseus.tufts.edu/*)

- Automatic Reference Librarians for the World Wide Web University of Washington, (*http://www.cs.washington.edu/research/diglib/*)

Undergraduate Emphasis

➢ Using the National Engineering Education Delivery System as the Foundation for Building a Test-Bed Digital Library for Science, Mathematics, Engineering and Technology Education University of California, Berkeley, (*http://www.needs.org/*)

➢ Columbia Earthscape: A Model for a Sustainable Online Educational Resource in Earth Sciences Columbia University, (*https://wwwc.cc.columbia.edu/sec/dlc/earthscape/*)

➢ Research on a Digital Library for Graphics and Visualization Education Georgia State University, (*http://asec.cs.gsu.edu/asecdl-nsf-dli2/index.html*)

➢ Digital Libraries for Children: Computational Tools that Support Children as Researchers University of Maryland, (*http://www.cs.umd.edu/hcil/kiddiglib/*)

➢ A Digital Library of Reusable Science and Math Resources for Undergraduate Education University of North Carolina, Wilmington.

➢ Planning Grant for the Use of Digital Libraries in Undergraduate Learning in Science Old Dominion University, (*http://dlib.cs.odu.edu/*)

➢ The JOMA Applet Project: Applet Support for the Undergraduate Mathematics Curriculum Swarthmore College, (*http://forum.swarthmore.edu/joma_applet/*)

➢ Virtual Skeletons in Three Dimensions: The Digital Library as a Platform for Studying Anatomical Form and Function University of Texas at Austin, (*http://www.eskeletons.org/*)

➢ The NSF/DARPA/NASA   Digital Library Initiative (DLI). In the Digital Libraries Initiative Phase 1, there were six federally funded projects in   digital library research, with partnerships led by universities. The individual projects are listed below.

➢ University of California, Berkeley: An Electronic Environmental Library Project.

➢ University of California, Santa Barbara: The Alexandria Project: Towards a Distributed Digital Library with Comprehensive Services for Images and Spatially Referenced Information.

➢ Carnegie Mellon University: Informedia: Integrated Speech, Image and Language Understanding for Creation and Exploration of Digital Video Libraries.

➢ University of Illinois at Urbana-Champaign: Building the Interspace: Digital Library Infrastructure for a University Engineering Community.

➢ University of Michigan: The University of Michigan Digital Library Project. (A DLI project.)

➢ Stanford University: Stanford University Digital Libraries Project.

➢ The Computer Science Technical Reports Project (CSTR). Collaboration Involving CNRI, five universities, and the Library of Congress.

➢ Centers for research on digital libraries in the U.S.A.

➢ Center for Intelligent Information Retrieval.

➢ Center for the Study of Digital Libraries.

➢ Center for Electronic Texts in the Humanities.

➢ Center for Research on Information Access.

➢ The Electronic Text Center at the University of Virginia.

➢ The Information Infrastructure Project.

➢ Rutgers Center for Information Management, Connectivity, and Integration.

Programs and projects outside the U.S.A.

➢ *Canadian Initiative on Digital Libraries (CIDL):* An alliance of Canadian libraries interested in improving communication and Coordination in the development of Canadian digital library resources. eLib: Electronic Libraries Program (UK): A broad program of projects addressing a wide range of digital library issues.

➢ *European Research Consortium for Informatics and Mathematics (ERCIM):* A consortium of research organizations from thirteen European countries, which provides a framework for collaboration.

➢ *Distributed Systems Technology Centre (DSTC):* A joint venture by the Australian Government's Cooperative Research Centres (CRC) Program and participating organizations to develop the technological infrastructure for global distributed systems.

➢ *New Zealand Digital Library:* An interactive system with collections of

computer science technical reports and literary materials. The site includes pointers to the relevant project descriptions, technology, and related information.

➢ ***Digital Library Network (DLNet):*** This page describes digital library work at the University of Library and Information Science, Tsukuba Science City, Japan, in English. From here, follow links to discussions of related workshops and the Multilingual-HTML Browser Project.

Joint NSF/JISC international digital library projects

In late 1998, the National Science Foundation in the United States and the UK Joint Information Systems Committee issued matching calls for proposals for multi-country, multi-team projects that would involve at least one research team in the US and at least one in another country to address research challenges of digital libraries that had international scope. Below are a list of six projects that have been funded so far. Please see the D-Lib.

Magazine article "The Joint NSF/JISC International Digital Libraries Initiative" (*http://www.dlib.org/dlib/june99/06wiseman.html*) for more information about the joint program.

➢ Cross-Domain Resource Discovery: Integrated Discovery and use of Textual, Numeric and Spatial Data, University of California, Berkeley / University of Liverpool

➢ HARMONY: Metadata for resource discovery of multimedia Digital objects, Cornell University / ILRT / DSTC

➢ Integrating and Navigating ePrint Archives through Citation-Linking, Cornell University / Southampton University / Los Alamos National Laboratory

➢ Online Music Recognition and Searching (OMRAS), University of Massachusetts / King's College, London Emulation options for digital preservation: technology   emulation as a method for long-term access and preservation of digital resources, University of Michigan / CURL

➢ The IMesh Toolkit: An architecture and toolkit for distributed Subject gateways, University of Wisconsin-Madison / UKOLN / ILRT

26   References

1. See http://www.ukoln.ac.uk
2. See http://www.peoplesnetwork.gov.uk
3. Lee, S (2000) Digital Imaging: A practical Handbook. Library Association Publishing.

4. See http://www.ebrary.com
5. See http://www.netLibrary.com
6. See http://www.cni.org
7. See Http://www.dlib.org