Digital Libraries and Technical Distance Education

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Abstract ? **In this paper the author summarizes main aspects of distance education in engineering, its availability, and teaching and learning issues as well as its benefits and limitations. Next, the concept of Digital Libraries as a support element for distance education is introduced. Gateways to technical information are described, and a list of E&T electronic resources are presented.**

The development of digital collections as an integral part of the teaching-learning process is discussed, and some new integrated tools such as the digital reference desk is presented. Finally, some of the concerns about digital libraries are analyzed.

Index Terms ? **Digital libraries, engineering information, distance education.**

I. Introduction

Distance learning is a very important part of today's engineering education. Universities from all over the world are developing programs to provide online and other type of distance courses to engineering and technology students. This constitutes a major investment in personnel and resources, while the benefits for the institutions and the students are often worth the effort. Distance learners require similar academic support as students taking courses on campus: the Library is the resource discussed in this paper.

Digital Libraries are complex organizations that require a great among of professional expertise, time, funding, technical and administrative knowledge to make them successfully functional. Digital Libraries for the support of engineering and technology programs are evolving too and are considered to be one important part of providing quality technological education.

2. Distance Education in Engineering

There is a strong movement toward the use of telecommunications and computers in a converging mode to deliver education to engineering and technology students [1]. Technical personnel are constantly under the need to upgrade their knowledge to keep pace with the latest developments. At the same time, engineers are under severe limitations on time and space to attend regular courses on campus.

The potential of distance education in engineering has being discussed to a great extent in the literature. In a recent article [2] the author makes reference to: 1. improve access to engineering programs; 2. enhance the quality of instruction; 3. improve productivity of the institutions; 4. respond to a demand from new technologically oriented students and 5. help overcome the barriers to lifelong learning.

Distance education as a technology-driven activity has advantages and disadvantages. These are some of the benefits and being reported in the literature [3]: 1. cost 2. effectiveness of delivering courses in extended areas and even abroad; 3. its adaptability to different learning styles; 4. real-time interactivity between students and the instructor; 5. its multimedia capability; 6. its adaptability to small classes at different locations.

As the difficulties and limitations in distance education become better known some of the following has been reported: 1. cost; 2. in some cases the technology is not adaptable to different learning styles; 3. there could be interferences in the delivery due to external causes; 4. it requires a certain level of expertise to operate and support; 5. it requires consistent commitment in cost and personnel; and 6. there can be some technological restrictions on the receiving side. Interesting enough most of these advantages and difficulties also apply to the technologies under which the digital library operates.

As in any new and active field, there are still very important issues to consider, for example: 1. evaluation of programs; 2. student evaluation; 3. a rewarding system to faculty members involved in distance education; 4. proper professional recognition for the creation of electronic educational products; and 5. a long term institutional commitment. Nevertheless, a general consensus is that distance education technology and programs are here and will continue to be. It is therefore appropriate to continue exploring support systems - like the digital library – that will help to further develop new services and programs for distance learners.

3. Digital Libraries

Academic libraries are facing interesting challenges [4] to develop services in support of distance education programs. In order to help libraries identify issues related to distance learners, professional library groups such as the Association of Research Libraries (ARL) and the Association of College and Research Libraries (ACRL) have written guidelines for distance learning library services. Furthermore, there are some basic considerations to follow in order to ensure the success of a digital library project: planning is the first step,

Manuscript received on December 15, 2001. This work was supported in part by NIU Libraries and NIU Graduate School.

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there must be communication channels between the instructors and the Library – a collaborative approach in this case could be beneficial to both parties. Procedures and policies must be established, and a sound collection development program must be in place. Funding is another consideration in this process that has to be discussed with the appropriate institutional administrators.

It is important for libraries to identify user's needs [5], for example, the identification of specific materials needed for a class. The Library must also have the opportunity of moving traditional services to the online environment. These services include interlibrary loan, instruction, and reference.

Since electronic products available from commercial publishers are subject to a license agreement, the Library spends time and effort obtaining the most favorable contracts. Also, the Library gets involved in consortia agreements to obtain these products and services at a lower cost.

A. Technical Gateways

Responding to the demand for online information and to provide services for distance learners, academic libraries in collaborative efforts have created technical gateways. These are some examples:

Reference [6] reports about the activities in Library of the Open University in London, England. The OU Library has an electronic service available to students taking courses in the distance education program offered by the university. The university has 180,000 students registered in distance-learning courses and the Library provides access to 4,000 electronic journals. In addition, each course offered has its own web site where Library databases and a selective list of Internet resources are included. These Internet resources are relevant to the subject of the course. Access to the journals and other resources are limited to students enrolled in courses.

The Engineering E-Library, Sweden (EELS) is a collaborative project of The Swedish Universities of Technology Libraries. This is a consortium of the six most important research technology libraries in this country. They cooperate in providing services to their institutions, research programs and to industry. EELS provides access to quality information resources from the WWW. Resources are listed following a subject classification used by Engineering Information Inc. (Ei), a well kwon commercial publisher.

A group of subject editors is responsible for the selections on these Web resources, the group of 14 subject experts are distributed as follows: architecture; biochemistry; chemistry (2); civil engineering; computer science and engineering; economics; energy technology; environmental science and technology; fire engineering; mathematics; mechanical engineering; physics; and polar research and cold climate engineering. They all are staff members from the Swedish Universities of Technology Libraries.

At the EELS site, most of the selected resources are free, however, some very important commercial databases are listed and they require a password.

One of the first initiatives for creating public engineering and technology information was created by the well known Edinburg Engineering Virtual Library (EEVL). EEVL is a collaborative effort of Heriot-Watt University, Cranfield University, the University of Birmingham and the University of Ulster. Other institutions making contributions to this project are the Emperial College of Science, Technology and Medicine, the Nottingham Trent University, the University of Sheffield, and the LTSN Maths, Stats and OR Network.

The engineering section covers: Aerospace and defense engineering, bioengineering chemical engineering, civil engineering, electrical, electronic and computer engineering, engineering general, engineering design, environmental engineering, manufacturing engineering, materials engineering, mechanical engineering and related industries, mining and mineral processing, nanotechnology, occupational safety and health, and petroleum and offshore engineering.

In addition, EEVL offers other services such as specialized search engines and collection of e-journals; among these services are a collection of engineering e-journals, a list of engineering newsgroups, the Recent Advances in Manufacturing (RAM) database, the Offshore Engineering Information Service, and the MathGate at EEVL.

The Australasian Virtual Engineering Library (AVEL) is another important gateway for information in engineering and technology. AVEL is a collaborative effort of The University of Queensland, The University of Melbourne, The University of New South Wales, Monash University, Queensland University of Technology, Institution of Engineers, Australia, the Distributed Systems Technology Centre, and the Centre for Mining Technology and Equipment. This service provides information to the Australia region including other countries in the area. The Australian Digital Theses service provides information and full-text about dissertations from 10 universities. The AVEL Newsletter keeps members informed about news and services.

Engineering categories covered by AVEL are: chemical engineering, civil engineering, computer science & IT, electrical engineering, engineering education, environmental engineering, engineering, general, mechanical engineering, and mining engineering. Emerging engineering topics covered are: biomedicine, biotechnology, informatics, materials, nanotechnology, robotics, solar energy, and sustainable development.

In Brazil, the Scientific Electronic Library Online - SciELO provides access to a selection of sixty-three scientific journals. This is a project supported by the Fundacao de Amparo a Pesquisa do Estado de Sao Paulo and The Latin American and Caribean Center on Health Sciences

Information. The collection has journals covering the following subjects: agricultural sciences, applied social sciences, biological sciences, engineering, exact and earth sciences, health sciences, human sciences, and linguistics, letters and arts.

A similar site in Chile exists, the scientific library - SciELO Chile also provides full-text journals in the following areas: agricultural sciences, biological sciences, botanical sciences, chemistry, earth sciences, geosciences, health sciences, human sciences, literature and mathematics.

SciELO Chile is sponsored by the Comision Nacional de Investigacion Cientifica y Tecnologica, and the Centro Latinoamericano y del Caribe de Information en Ciencias de la Salud. Twenty four titles are included in this collection.

B. Engineering and Technology Electronic Resources

Engineering publications are produced mainly by commercial publishers, government agencies and professional societies. A recent article [7] surveys the current status of Web based engineering resources. He offers a list of free and for-pay resources available in most American technical libraries.

Commercial databases. Some of the most heavily used are: *CompendexWeb*, *INSPEC*, *Applied Science and Technology Abstracts*. Some others are, for example: *Metadex*, *Aerospace Database*, *Ceramics Abstracts*, *Pollution Abstracts*, *Mechanical Engineering Abstracts*, *SAE Global Mobility Database*, *Energy Science and Technology Database*, *Transport*, *Science Citation Index*, and *Dissertation Abstracts*.

Government databases. These databases provide important technical information: National Technical Information Service (NTIS) database, NASA CASI Technical Report Server, DOE Reports Bibliographic Database, DOD STINET, and the Earthquake Engineering Abstracts.

Specialty databases. These databases are available from government agencies or from corporate Web sites: *NIX-NASA Image Exchange*, National Institute of Standards and Technology (NIST) numeric databases, *Thermodex*, *EE Circuit Archive*, and *Data Bookshelf.*

Commercial e-journals. These publishers have collections available by subscription: Elsevier's *Science-Direct*, Springer-Verlag, Kluwer Academic, Academic Press *IDEAL* system, Wiley, Taylor & Francis, Thomas Telford, and Cambridge University Press.

Society e-journals. These are examples of societies with collections of e-journals: Institute of Electrical and Electronic Engineers (IEEE), IEEE Electronic Library, The American Society of Mechanical Engineers (ASME) journals online, The American Society of Automotive Engineers (SAE) technical papers, the American Institute of Aeronautics and Astronautics (AIAA) technical papers, The Society of Photo-optical Instrumentation Engineers (SPIE) journals, and The Institute of Industrial Engineers (IIE) journals. Other related societies moving journals to the Web are: The Association for Computing Machinery (ACM), the Society for Industrial and Applied Mathematics (SIAM), American Chemical Society (ACS), American Physical Society (APS), and the American Institute of Physics (APS).

Technical reports. Technical reports are found also in state agencies or corporate Web sites, for example: DOE Information Bridge, the NASA Technical Report Server, NTIS Web site, Environmental Protection Agency (EPA), the European Space Agency (ESA). The Networked Computer Science Technical Reference Library NCSTRL), and On-line CS Techreports.

Standards. They are available from national or international agencies and from commercial vendors such as: The American National Standards Institute (ANSI), National Standards System Network (NSSN), The International Organization for Standardization (ISO), The World Standards Service Network (WSSN). Information Handling Services (HIS), Global Engineering, Document Center, CCS-Custom Standards Service, and DODISS web site.

Patents. Examples of patent services are: The U.S. Patent and Trademark Office (PTO), the European Patent Register online, World Intellectual Property Organization, and the Canadian Patent Database. DIALOG and other vendors.

Company Catalogs. Examples of these kinds of catalogs are: *Thomas Register*, *Design-Info*, AMM Online Metals Marketplace, Metals supplier Online, Electric Net, Electronics Manufactures on the Net. MSC Industrial SupplyCompany, The Grainger Industrial Supply, McMaster-Carr, and AMP. Also, Information Handling Service.

Software. Web sites where students can download or find information are: Shareware.com and ZDNET. All Internet Shopping Directory, and SciTech International Online. The Linux User's WWW Page, Autodesk, Mathworks, and Wolfram Research.

Books and Reference tools. These are important sites related to these kinds of materials: Publisher's Catalogues Home Page, Books in Print, The Amazon.com, and Bibliofind. CRC Press handbook collection, *Encyclopedia of Electrical and Electronic Engineering*, and the *Kirk-Othmer Encyclopedia of Chemical Technology*.

This is a very robust body of technical information resources that would provide excellent support to distance education programs in engineering and technology.

4. Digital Collections

The concept of digital libraries encompass more than just a place to find electronic books, journals, references materials

and the like, but also entails being defined [8] as a network environment where members of a community can use as a "learning space." This is a network environment with and extensive collection of materials that can be incorporated into a learning process for students, or, in other cases for real-time research or for lifelong learning.

The Human Genome Project [9] is an electronic library composed of microbial, plant, and animal genomes, 3D protein models and experimental data. This is an example of where students and researchers interested in learning and understanding the processes of life would work in this learning space and be able to accomplish a great deal before approaching the lab bench. In the Digital Library for Earth System Education (DLESE) [10] students find a wealth of earth science data presented in a friendly environment. A number of services created in the library allow users to use materials and create their own tasks. DLESE is also a network of sharing resources and services for this specialized community.

The National Science, Mathematics, Engineering, and Technology Education Library (NSDL) [11] sponsored by the National Science Foundation (NSF) in the United States is another major project with the purpose of improving the quality of education in these fields. In this initiative, institutions are funded by a selective grant process and as of today several projects are under development. NSDL is a national library an online network community providing learning resources and services.

In an example of outcomes [12] expected from these types of communities the author argues that there are at least five skills students would acquire by actively participating in them. Students would be able to: acquire, organize and analyze technical information, as well as, being able to ask and answer technical questions. Existing interactive on-online learning environments for engineering and technology can be enriched with educational collections like the ones mentioned above.

5. The Digital Reference Desk

Libraries' collections and services have gone through a number of transformations in the last decade, these changes are in response to the availability of new technology, new electronic products and to changes occurring in higher education. Distance education learners are often miles away from the institution they are taking courses from, and their work schedule makes it difficult to come to the physical library to work on their assignments, therefore, the Library has designed ways for patrons to communicate their needs. In addition to phone calls and e-mail messages, the digital reference desk is another way users can interact with library faculty and staff.

A recent report about virtual reference desk [13] indicates that most academic libraries in the United States have a digital reference service that is "a mechanism by which people can submit their questions and have them answered through e-mail, chat or Web form." Initially, the services was a link on the Library Web page often called "Ask a Librarian" where users post questions on a Web form and are answered by a subject specialist at a later time. More recently, a real-time digital reference service has emerged, for example, at North Carolina State University [14]. The Library uses a specially design reference software (LSSI's Virtual Reference Desk) in which the librarian can in real-time interact with the user (chat) as well as being able to launch on the screen online reference resources such as the library catalog. A new step forward in innovation is the installation at the reference desk of a TV camera, in this case the communication is face-to-face. In order to be able to operate the user must have access to the system which could be located at a classroom in a remote location.

6. Conclusions

Distance education for science and engineering is a vehicle to provide quality and specialized education to students that for several reasons can not attend regular classroom courses. The role played by digital technical libraries is an important one to ensure distance learners have the same kind of resources at their disposal. Libraries are making good efforts to ensure that quality collections and services are provide to students in remote location. Nevertheless, these services are also heavily used by staff and students on campus.

There are many other issues concerning the digital library that have not been covered in this article, for example, its administrative organization, cost, the capacity of maintaining collections, and the evaluation issues related to the services and collections of the virtual library.

For countries in developing areas – where the concerns about cost might be very crucial – it is important to realize that large digital library initiatives are collaborative efforts. In this case, multi-national agencies and international organizations must get together in order to fund, design, develop and maintain digital libraries tailored to specific regional educational and industrial demands.

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