Engineering Virtual Libraries for Engineering Distance Education Students

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Abstract

Once an engineer graduates and starts his career, it can be challenging to pick up an advanced degree due to time constraints and travel distance to universities that offer the desired degree program. Universities are tackling this problem by making distance education more readily available to engineering students. Providing students with access to quality research materials in the field of engineering is an essential ingredient to the success of these programs. This is where engineering librarians have an important role to play by developing online collections, communicating with faculty about online books and journals, and assisting in the creation of online reserves collections. The online engineering library need not be an overwhelming expense if the librarian is creative with leveraging relevant government sources. The library must adapt to meet their needs for both the benefit of all students, and the University.

Keywords
Virtual Library

I.   Introduction

This conference recognized distance learning as one of the topics deserving of discussion and the intent of this paper is to explain to an audience of engineering educators why a virtual library is essential to the success of distance education. While engineering schools are responding to the need to educate distance learning students by rehabbing classrooms for microphones and cameras so that they can see what is going on in class, but the library also has a role to play. My school's response to this challenge will inform this paper.

A. Statement of the Problem and the Solution

The problem of distance education is primarily one of inertia. From Socrates in the Lyceum, to the present day, the teacher and students have gathered together and the teacher spoke and the students listened, a system I once heard described as, "the sage on the stage." And not so long ago, when class was over and the students needed to do research, they went to the library on campus, where the shelves had books and journals and the all-important print indexes which allowed students to find what was in the journals. This system was standard for many of today's faculty, but the Internet Age and the growth of electronic sources has put an end to the old system as the standard method of both teaching and library research.

Now students are found both in and out of the classroom, and it is the students outside the classroom who are the concern of this paper. Students now have alternatives to the traditional model of education such as the University of Phoenix, MOOCs, and the universities themselves, to name just a few. Added to that, they have online alternatives to the library itself, the most important of which is Google.

How is the library supposed to cope? The library can do more than cope, it can master these changes by leveraging its skills and the technology that it has, and to incorporate the online materials that will allow the creation of the virtual library, available for all students, both close and distant. Experience has shown that students and faculty on our campus prefer online to print, so by serving the distance student by expanding online sources, services are improved for everyone.

B. Literature Review

The substantive literature on distance education and virtual libraries goes back at least to 1996, when Faulhaber says in the first sentence of his article, "Distance learning requires digital library support."[1] By 2003 this attitude was reinforced in Jurkowski with "Today, the library's web site is often viewed as the library in and of itself."[2] In Shepley there is an examination of the cooperation that there should be between library and faculty in a paper about the Saskatchewan Institute of Applied Science and Technology Libraries to ensure that students had access to the materials that they needed for their studies.[3] The use of library resources from outside the library and organized by academic college was examined Bridges and the results showed that, "Subjects in the College of Engineering were significantly less likely to use virtual library resources when compared to students in the College of Liberal Arts."[4] Note that result was for all students accessing the virtual library from outside the library building and not broken down into engineering distance education students. It appears that there is a need to survey engineering distance education student's virtual library use. Such a survey is not included in this paper, but should be done in the future.

II.   The Need

These changes must be built upon an assessment of what is needed for online materials. While there is no one way to assess need, universities should begin by assessing what needs are not presently being covered by the library's collection. Hopefully, administration, professors, and librarians can work together to identify the needs a distance education program will have.

Distance education's advantage is that it allows universities to expand the number of students paying tuition, without expanding either the physical plant, or the ranks of instructors. Some pioneers call these distance education activities, Massive Open Online Courses (MOOCs) and some do not charge tuition, but also do not grant credit for degrees. Most universities are more small scale in their distance education activities and charge tuition and have just a few students taking credit courses online.

Other universities invert the distance education program and teach students on campus, and then send them out in a near co-op activity to work in companies applying their degrees and earning credit, and they also need support from the library. Librarians need to closely monitor what their

departments are doing in the area of distance education and be prepared to respond quickly. Providing responsive services to their students and faculty in an environment of change is an underlying theme to the library profession these days.

A. Students

Students have many motivations to take classes through distance education, but they are justified in expecting that in paying their tuition, the University will provide them the research materials that they need to earn their degree. It is reasonable to suspect that any university that does not do this will soon be wondering why their distance education program is lagging in enrollment.

Students have many motives for returning to school, but increasing their skills and credentials to increase their value and therefore their earnings has to be a major reason. The ASEE publishes annually a survey of salaries in the engineering professions which confirms that engineers with advanced degrees earn more. Students may know than an advanced degree may increase their future earnings, but they also need income today so distance learning that allows them to keep their present job may make all the difference on whether they decide to earn their next degree.

Library support for the distance student is essential to the operation of the distance education program. Many libraries already have moved most of their journal collections online, but that is only part of the materials students need. Students will need the reference books and handbooks which will provide basic answers that arise in their profession and which online journals rarely do a good job of answering.

The typical problem with an overreliance on online journals to provide the materials that students need is that many of the academic journals online are good for the modern research, but poor on the background. There is a need for online encyclopedias and handbooks that place the fundamentals of engineering in a convenient format for the student. These fundamentals include standards, constants, and the tables and graphs for fundamental data.

The best example I can give for the need for reference works arose when I was teaching a class of chemical engineering students in the use of online sources. I had just finished with the journal sources when one student raised his hand and asked, "How do I search this database to find the best synthesis method for a chemical?" I had to think about what he was asking before I could say, "For that information you need to look at an encyclopedia of chemical engineering to find the standard synthesis methods." Librarians need to use their interactions with engineers to not only know what sources their patrons need, but also to know how they use those sources.

B. Libraries

The first source of data for the needs of students should be Inter-Library Loan (ILL) statistics to distance education students, and then ILL stats for the regular student body. These numbers will be the first to tell you what the library does not own, but is needed. The second source of information should be the dissertations and theses granted by the university, and the third should be knowledge of the syllabi of the courses taught to the distance education students.

ILL stats are a gold mine of information and if your library has a good ILL librarian the librarians with responsibility for collections should be peppered with suggestions for journals or

other sources that are in high demand, but not yet owned by the library. Most engineering faculty does not realize the level of collaboration between librarians which is needed to keep each other informed of high demand sources and topics.

Dissertations and Theses are the single best source for what are the major research areas on a campus. Naturally, the collections in these areas need to be built to a very high standard and purchases in those areas should be prioritized. One may find that certain topics, like plasma science and materials science may have more research being performed on campus in different departments than even the researchers realize.

One final technique for evaluating the collection is the librarian interviewing faculty on their research, their teaching, and finding out what needs remain to be met in the library collection. I strongly recommend that all faculties first, share their research needs with the library, and second respond favorably if asked to participate in an interview with their department's librarian. There is no substitute for human interaction to help a librarian determine what needs to be improved in the library.

While the virtual library must be built up, it must be done in an environment where all parties involved, students, faculty, and librarians understand the budget constraints that will control how much the library can buy and how fast. Most of the development of the online collection will be done by prioritizing online books over print books. This can usually be done within the regular book budget, supplemented by one-time monies and gifts as they become available. The process by which the virtual engineering library can be built up is not intended to be an all-or-nothing method, but it does describe processes in which a library can leverage their current collections and systems, and economize on spending to build up their engineering virtual library.

A. Catalog

The online library catalog is fundamental to any functioning library. Most engineers may be familiar with searching their local catalog, but they have no idea what functions are supported in the background of their library's catalog. A standard library catalog has several modules; a public module, an acquisitions module, and a cataloging module in the background are all important to the functioning of the library and it is good background to describe this further to an audience of engineers.

The public module is the library catalog as the public sees it. It is searchable by keywords, titles, author names, subject headings and call numbers. It supports printing and emailing search results, and lets the reader know if a book is on the shelves or checked out. In a virtual library, it will have links to online material that the reader needs. The library catalog is now a virtual library and on the Internet for the benefit of all at the university. It is also part of the authentication process by which publishers recognize what patrons are members of an institution that either subscribes to their journals or purchased their books and is entitled to access.

The acquisitions module manages the process of acquiring materials for the library. Major research libraries acquire their materials in a variety of ways and all must be managed in the catalog. Firm orders, are one-time orders that may be initiated by librarians, either on their own initiative or at the request of a patron, that are generally placed with a library middle-man who

earns his keep smoothing the process between libraries and publishers and keeping track that the orders placed are orders fulfilled. An approval plan is a system set up by the library and the middle-man that the library will buy books that meet the criteria set up in a profile. The profile may be as simple as saying the library will buy everything by a certain academic publisher, to as complex as saying I will take those books costing under $200 in the field of materials engineering and published online. The process of ordering books is computer-managed, complex, mostly invisible to the patrons, and absolutely essential to the functioning of a library.

The cataloging module might be most relevant to the virtual library. Most cataloging these days is called copy-cataloging, and amounts to sharing the burden of cataloging across all libraries. Internationally, the organization most associated with cataloging is OCLC, which among other activities outside the scope of this paper, sells cataloging records in a format used in library catalogs. When the "book" a library buys is a computer file hosted on a publisher's website, the nature of cataloging changes a bit. First, the cataloging record must provide an obvious link to the file, and second, the library must guard against "link rot" and the disappearance of the file from the catalog. Libraries and publishers have turned to the Permanent URL or PURL or the Digital Object Identifier or DOI which provides a links at the journal article level that should never go away. DOIs also work in science and technology databases.

Most libraries have websites where associated information about the library, such as online forms to request library services, links to databases, and other information like library hours of information is found. Access to science and technology databases is usually from the website and while not all of the information in them includes full-text or PDF of articles, papers or books, a great deal is, which makes the website key to the virtual library. A well-designed website needs to visually coordinate sources, services, and information students need.

Services of use to distance education students include the Inter-Library Loan system. It has long been recognized that no library can own everything in the world, so ILL is a necessary supplement. However, ILL was developed in one world where all the students and professors were on campus, and it is an imperfect solution for distance education. Present standard practice is to email PDFs of journal articles or book chapters to all requestors, whether on campus or off. This practice of emailing materials, whenever practical, makes ILL a part of the virtual library. When a student needs a whole book, or it must be delivered in print things become complicated. At worst, the library may need to deliver at its expense whole books that it owns by commercial parcel shipment and the student will then be responsible for paying to ship it back on time. Clearly, the service cannot satisfy all patron needs conveniently all of the time.

The first problem ILL poses for distance students it is mediated information retrieval in a world that only wants unmediated information retrieval. The second is that eventually ILL must deal with the issue of supplying print materials to distance education students, and that can become impracticable if the number of books is too large, or the student does not have access to convenient shipping. I was told once that one distance education student was "attending" class on a US Navy ship on patrol. Obviously, such a student must take what he can get online and hope that is enough.

Even if shipping materials is theoretically possible, there is a good chance that there are other reasons that ILL is impractical such as time for deliver versus deadlines for papers, or the number of materials needed to be shipped impose a burden when the student has to bear the cost of shipping the materials back himself.

It is best to construct a virtual library for distance students that do not rely on shipping print. The evolution of the publishing industry is starting to make it a prudent purchasing strategy to prefer to buy online books as opposed to print.

Sometimes, a library is part of a consortium that permits limited borrowing privileges across its members. In Alabama, that consortium is called **AL**abama **LI**braries **E**xchange **S**ervice (ALLIES) whose members include, the University of Alabama, UA-Birmingham, Auburn University, AU-Montgomery, and Jacksonville State University. Enrolled students at any of these universities may borrow books from any of the participating libraries. It would be worth it for any distance education student to see if such an arrangement is available in his own state.

B. Survey what is available online

Part of what is available online is free, and students are finding that information all the time. For librarians the selection must be a little more rigorous and the evaluation process for websites must parallel the evaluation process for books. If a library wants to make a link to a website it must answer questions like the authority, currency, and accuracy of the information on the site. These questions apply whether the material is free, or it costs money; there is no bargain to be had in useless, irrelevant, or inaccurate information, even if it is free.

But if it meets standards free is wonderful. US federal government technical reports and other data is a vast trove of scientific and technical information that is available copyright free. Before the Internet, this information was disseminated in print to United States Depository Libraries, either in print or microform or microfiche. Since the Internet age started this information has gone online. The main sources are NASA and its NASA Technical Reports Service, National Technical Information Service, and the Department of Energy which has information dating back to the Atomic Energy Commission in the 1940s, but it is better if you access DoE information through WorldWideScience.org which has DoE information and also scientific and technical information from countries around the world.

The U.S. Government funds pure and applied research, and often at a very technical level which can lead to problems for undergraduates who need more background explanation of the topic being investigated and more detail of how the research is conducted. Another problem is not all research is online, and may never be, so a familiarity with how to use the library catalog to see if the technical reports needed are available in print is also called for.

Despite all this information being on line, or rather because of it, the federal government does not have one index to this information. The best substitute for indexing this information is Google Scholar. Google Scholar leverages Google's massive computing power to make a scholarly paper only search engine. Beyond the index itself, the two best things about Google Scholar, is that it ranks papers by the number of times cited so highly cited papers are listed first, and it includes links to full-text.

These features result in Google Scholar being used as the primary search engine for research by many faculties on my campus. It also means that for interdisciplinary research, Google Scholar has no equal. Google Scholar is admirably platform neutral so it combines indexing from many disciplines into one nearly comprehensive search.

The US federal government publishes a great deal of information, but also foreign governments and international organizations. WorldWideScience.org has already been mentioned and it puts dozens of international government research databases together in one searchable database. Another excellent database is sponsored by the International Atomic Energy Agency. The IAEA puts online most of its technical documentation, including safety standards. The IAEA's generosity in putting this information online for free is unmatched by anyone else in the nuclear field, including the so-called "non-profit" professional societies.

While there is a considerable amount of free high-quality information online that a library that wants to economize may link to for the benefit of the researchers and students in its community, there is no disguising that government information sources only supply some of what is needed. With online journals already well supplied in most libraries, the remaining hole is in online books, particularly textbooks and reference books and encyclopedias. These sources both explain the basics in a field and demonstrate how to answer problems. Online handbooks and encyclopedias are also useful, especially in fields like chemical engineering.

The publishing industry is undergoing transformations and the transition from print to online is only the most visible change.

Another change is how libraries purchase their collections. While Inter-Library Loan has long existed, it is hard to develop a collection by a library purchasing one book and then sharing it with other libraries for the reason that if the topic is popular, the library should have the book anyway, and if it is not, it is unlikely that anyone would buy it anyway. Neither is the case when a consortium of libraries buys a database. The information is shared by all and hosted by one vendor so the information gets wide dissemination. Obviously, a sale to a consortium many more users and greater visibility for the product than a sale to just one library so publishers are willing to deal to sell to a consortium. While the distinction between a database that was purchased by a library and one purchased through a consortium may not be visible to the public, librarians are aware of the differences. This paper is not intended to be a "Consumer Reports" style review of library purchasing options, it is undeniable that a consortia deal in an area of collection focus might offer the biggest bang for the buck for a librarian looking to expand the online collection at the best price.

One of the best sources for reference books is commercial publishers. Certainly some professional societies publish excellent handbooks, but for encyclopedic information commercial publishers seem to have most of the market. Commercial publishers are moving their reference works online to fulfill demand for reference works seem to be able to justify the prices they charge. Government databases occasionally have reference databases, but these are often focused on narrow topics. Wikipedia may have its uses but it is rare to see it cited as a source of technical information. The final reasons virtual libraries need reference books is that for some

information for the distance education student, there may be no other source available with the information he needs. Materials science has fundamental property information that is only available in such sources as the ASM Handbook, so making such sources available online is crucial.

It is a sign of the progress in putting information online, that the presence of online scholarly journals is now considered the standard and print journals and print indexes are considered last-century technology. Students can now access at least a decade of archival journals online in almost all cases, but in some special cases like the JSTOR database, decades or even centuries of online journals are available, as is the case of the Proceedings of the Royal Society.

Online textbooks will probably be the last format to remain in print and be the last to go online since the publishers find the profit margins for print textbooks too good to ignore. It does appear that there are competitors online who are starting to make inroads into the textbook market, but that is more a trend to be observed than a reason for immediate action. Online textbooks will come eventually is the only conclusion to be drawn.

III.   Conclusion

What can be learned from all these trends converging on libraries and publishers?

First, horses for courses, one point that needs to be made is with the advent of online books and journals, librarians have better data than ever on which to make book and materials-buying decisions. A reference librarian used to be able to count on the university coming to him (or her) and watch trends on what questions people were asking. Now, to change the meaning of a term used by others, the "invisible university" does not walk in the library, does not ask questions of the librarian, but still needs online library sources and services. A librarian today needs usage statistics to know what is being used online and equally importantly, what is not. With this information, buying decisions may be directed to where they will do the most good.

One point that must be emphasized in creating a virtual library for distance education students is to tie the creation, organization, and purchasing to actual needs, instead of buying whatever package publishers have to sell as the best buy. Sometimes there are exceptions, but they do not excuse the librarian from having a finger on the pulse of distance education student usage and making sure that they have the materials they need in a format that they can use.

The opposite of usage statistics might be un-usage statistics. What are the students checking out? What is being used? If one sees that there is an online book for sale on metal stamping, but you have not statistics to indicate that anyone is researching metal stamping, without extenuating circumstances, like knowing the university will have a new course on metal stamping next semester, librarians need to direct their purchases to areas that are being used.

There has probably been more change in American libraries than at any time since the rise of the Carnegie libraries. Librarians have to adapt to new technologies and even more important, new patrons, and they have to do this without ever seeing some of these patrons.

Research universities with a commitment to educating distance students should ideally coordinate among the College of Engineering, the library, the budget program and their technology office to work out how to provide the materials the students need. Their work should result in:

An understanding between the parties about what materials are needed for the students, using what technology, to support what programs, with and adequate budget to support these changes.

The library needs to show what it can supply through a virtual library today, and the college of engineering needs to examine that list to assure that if their classes require more than what the library can supply that they support the funding that will make required materials available. Libraries stand ready to do what they can to support distance education students, but they want to work with other stakeholders to ensure that they are delivering the materials the students need.

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Bibliography of Online Sources

The following sources are not intended to be comprehensive, but serve to illustrate some of the high quality free engineering sources available online that could be used in an engineering virtual library.

ArXiv.org arXiv.org
Excellent pre-print server. Contains pre-prints in physics and also computer science.

Defense Technical Information Center www.dtic.mil
Unclassified research funded and published by the Department of Defense.

Google Scholar scholar.google.com
Comprehensive database indexing scholarly research from around the world. Not all papers indexed are available in full text.

NASA Technical Reports Server www.sti.nasa.gov
Includes decades of NASA technical reports and other items of interest for aerospace engineers.

National Technical Reports Library www.ntis.gov
All of it is available after registering, which is free. Decades of United States Government research from Department of Energy, USGS, EPA, and NASA.

WorldWideScience.org www.worldwidescience.org
Contains US Government databases, and other governmental science and technology databases from around the world. Not all of the information is in full text.

Biographical Information

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Andrew Wohrley is the Engineering Librarian at Auburn University Libraries. He also has responsibilities for Physics, and is the Patent and Trademark Resource Center Representative. He is also responsible for marketing the Data Repository to the campus. His interests include technology, patents, and online information sources.