With this approach in mind, UIL is now working on a number of phase 2 services beyond full text. These services include:

- Linking to a journal's impact factor in ISI's Journal Citation Reports
- Linking to a journal's directory information in Ulrichsweb
- Initiating author searches in a variety of databases, including the local catalog, Web of Science, and numerous periodical abstracting and indexing databases
- Searching for cited references in Web of Science
- Linking to Books in Print and book review services

Furthermore, the SFX link server now is an integral part of UIL's interlibrary loan services. At present, interlibrary loan staff regularly use SFX to check if an item can be found online or in local holdings prior to initiating an interlibrary loan. UIL will soon integrate SFX automatically into their interlibrary loan request form by combining the interlibrary loan form with the SFX citation linker. After a user enters whatever bibliographic data is at hand, the SFX server will first look to see if the full text is available electronically. If not, the SFX server will then look to see if the item is in the local catalog. If that search also fails, the user may then proceed to the next step of the interlibrary loan process. As a result, interlibrary loan requests for items already held locally, either electronic or in print, will be weeded out before they even make it to the interlibrary loan office. The entire process happens in just a few seconds.

Finally, UIL now is experimenting with a variety of mechanisms for using SFX as a backend to help faculty create links to full-text articles in their course reading lists. The library works closely with faculty in the development of resource lists for courses, and we want to provide an easy mechanism for faculty who use UIL's TWIST course Web server, or the WebCT and Blackboard servers, to guide students directly to full-text resources available electronically.

UIL also actively participates in the SFX/MetaLib Users Group (SMUG), a self-governed users group of which the University of Iowa is a founding member. SMUG provides an opportunity for resource sharing, especially for locally developed sources and targets and for niche databases. The group also acts as a sounding board for Ex Libris developers and identifies those areas of primary concern for customers at large. Most importantly, however, SMUG is a collection of unabashed OpenURL advocates, and a key effort of the group has been to promote OpenURL implementation with vendors, benefiting the entire link server user community. SMUG has watched OpenURL blossom and can offer information providers details about best practices for their OpenURL implementation. In particular, vendors who permit customers as much local customization as possible tend to be the most effective implementers of OpenURL. A particular stumbling block in some implementations is the vendor's inability to allow the customer to use its own customized icon and link text. The user's group experience with many vendors is that each customer is being told the same story that they are the only customer voicing concern with that vendor's implementation. As the OpenURL user community grows, information providers will be driven to better implement OpenURL in their environments, and the users group community will become an effective medium for passing along concerns of collective interest.

In the past year, link-server implementations have grown dramatically. In one year, UIL's local link-server implementation has matured into a service that has become invaluable to its students and faculty. More than seventy-five of UIL's licensed databases are now OpenURL-enabled, with links to more than 16,000 full-text journal subscriptions. Link servers provide libraries with a rare opportunity to leverage their access to Web-based materials while keeping local control over how the materials are presented and which links are most relevant to their users, proving to be important components in any integrated library system.

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A History of Web Portals and Their Development in Libraries

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This article studies the history of Web portals widely used in business-to-business and business-to-consumer Web applications

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in the late 1990s. Web portals originated from Web search engines in the early 1990s and evolved through Web push technology in mid-1990s to its mature model in the late 1990s. This article also compares Web portals with other popular media, such as radios and televisions, for their audience base and content broadness. As of January 2003, only a few libraries had adopted Web portal technology despite the widespread use of my.yahoo.com-type Web portals in the business sector. The article examines several reasons for the lack of portal development in libraries and concludes with a set of Web portal development guidelines for academic libraries. Some of the pioneer library portals are also discussed, as well as the California State Government, the first government portal to offer customization and financial transactions for individuals and business. This article concludes by probing a more fundamental question about general information storage and retrieval processes. In the last several hundred years, libraries primarily built hierarchical data structures and librarians provided information service without any search engines. In the past ten years, Web business communities have primarily worked on developing fast search engines for information retrieval without paying much attention to data structure. Now with the exponential growth of data on the Web, it is time that librarians and computer engineers work together to improve both search mechanisms and data structures for a more effective and efficient information service.

What is a portal? "Portal" has been the buzzword of the networked age since 1997. Portals were so popular in business-to-business (B2B) and business-to-consumers (B2C) applications that the business world borrowed an old jingle: "I'm a portal, he's a portal, she's a portal, we're a portal, wouldn't you like to be a portal, too?"

Portal derives from the medieval Latin word *portale,* meaning "city gate." *American Heritage Dictionary* defines a portal as "a doorway or an entrance, or a gate, especially one that is large and imposing." New definitions for portals in the networked environment can be found on many Web sites. A synthesis of these new definitions is as follows: a Web portal is a doorway that can be customized by individual users to automatically filter information from the Web. It typically offers a search engine and links to useful pages, such as news, weather, travel, and stock quotes. A portal can also be defined as a customizable Web search engine to reflect the MY trend in current Web development. The platform for a portal Web site is a search engine, but a portal is different from a general search engine in that it can be customized by individuals for automatic, constant search for specific information, and it can deliver the results to individuals in a predefined way. A customizable search engine is unique to the user; it is different from anyone else's.

The very early history of portals used by librarians can be traced back to the 1960s, when the first digital version of Index Medicus was created.[1] Some science librarians may still remember the customized weekly search in Medline for medical researchers and in INSPEC for physicists. This kind of canned search was predefined offline first by scientists and librarians together with a set of criteria. The canned search was performed by librarians against the weekly updated database tapes on IBM mainframes. Finally, the search result was delivered to scientists for the most recent developments in related fields. In the business community, CEOs often had various Executive Information Systems (EIS) before the Web came into existence in 1992. EIS was developed to provide top decision makers with broad, diverse content according to previously defined criteria. Both librarians' canned searches and the EIS service can be seen as human-controlled portals as they provided customized information in a timely manner through human mediation.

The history of current Web portals can be traced back to the Boolean search technology developed in 1994 and 1995.[2] Due to the exponential growth of Web pages, users cannot locate Web files by conventional means, such as using directories like those in phone books. Search engines offer document content with full-text indexes and direct links to the documents in the Web environment. Initially, most Web users were researchers and educators with high-speed Internet access. They were very excited about the advent of the search engine. Academic librarians all over the country started to offer college-level library instruction courses on Web search engines as early as 1992. When more and more people started to use the Web, not just for research but for entertainment and daily information gathering, it became evident that giving people a complicated search command language to find popular information was not efficient. In order to address the average user's frustration and reduce the *seek time* for relevant information, the search sites added the function of channeling or categorization—filtering popular sites and documents into preconfigured groups. This categorization is a step further from the general Web site; the Web provides broad information for a broad audience and categorization provides narrowed information for a broad audience. The concept of categorization is not new. Just as in TV channels, Web channeling can provide the audience with specialized content in sports, politics, weather, and news. A good analogy is to consider the general Web site as the only radio station in town back in the good old days. In today's Web, categorizations are like TV channels, and Web portals are like pay-per-view (except the payment is a free registration for most Web portals). Sometimes people also refer to categorization or channeling as Web portals, which is true in the sense that it is an earlier stage of a portal. However, in this article, Web portal refers to only the Web sites that can

be customized by individual users. Figure 1 illustrates the different Web technology for different audiences.

There has been one important intermediate technology between search engines and Web portals that has been forgotten—push technology. Instead of the individual user having to pull information from the Internet, push technology allows a Web site to deliver the selected information directly to the user's desktop. Push is a general term for any information-delivery client software or service that can be customized to notify users of new information and to automatically send that information to users' desktops. In order to use push technology, a small software program known as a push client has to be downloaded from the push service Web site and installed on the client PC. The push client software provides the interface to the push service. Several of the push pioneers included PointCast, Marimba, BackWeb, and GM's Cyberworks business unit. During 1995 and 1996, PointCast was the name representing a new business model to the online service environment.[3] PointCast's business model was described as beaming news over the Internet from various sources according to what people needed. The key here was the delivery of *customized* information directly to users' desktops. PointCast let users define an information category and receive data updates without having to request or search for them again and again on the Internet. The original PointCast system aggregated news from fewer than ten sources in spring 1996. Within a few months, Web content providers from all kinds of *channels* asked PointCast to be their information distributor. PointCast users increased by one million each month in the first twelve months after its first release in 1996. C/NET honored PointCast with the Best Internet Application Award in 1996. PointCast used free downloads and personalized information as its major selling points and the Microsoft Corporation announced in 1996 that PointCast news broadcasts using Internet technology would be included in Windows operating systems by July 1997.[4] Figure 2 is an archived PointCast Web site as of April 1997.

	Audience	
Content	**Broad**	**Narrow**
Broad	Broadcast: same content for large, diverse audiences; i.e. first generation static Webs most universities had up to year 2003	EIS: broad and diverse content built from enterprise intranet applications for corporate decision makers and researcher
Narrow	Categorization: special content for diverse communities, such as news, weather, and stock quotes; also called channels	Portals: specific content intended for individuals; content can be customized by individuals from client computers

Figure 1. Content versus Audience on a Broad to Narrow Scale

Unfortunately, PointCast did not become the next Netscape or Yahoo! due to several reasons. In 1997, when push technology was hot, there were several articles questioning the future of the new technology. In 1997 Oliver Pflug, a columnist for *Computerworld*, argued in an article titled "'Push' Technology, Dead on Arrival" that client-based push software could severely slow down a corporate computer system by creating nonwork-related traffic jams, and that the software required more disk space and memory than most PCs were equipped.[5] Ken Auletta argued from an academic point of view that PointCast failed because of its poor management.[6] Not uncommon among entrepreneurs, the founders of PointCast—Christopher Hassett and his brother Gregory Hassett, along with Christopher's wife Janet—were entrepreneurs but not management professionals. They did not transfer their company to professional management until it was too late. Christopher Hassett declined an offer made in January 1997 by News Corp of Los Angeles for $450 million (some companies valued PointCast to be worth more than $750 million in 1997).[7] In 1998 PointCast failed its IPO and in 1999 the company merged with Launchpad Technologies for a measly $7 million deal, forming EntryPoint.[8]

Push technology may be dead, but the concept of customized content auto-delivery transformed into server-based Web portal technology. Portal Web sites not only provide search functionality and a library of categorized content, but they also have expanded to offer additional features such as access to special interest sites. A few examples of these sites are my.fool.com for financial information, personal travelocity.com with individual logins for traveling information, and my.weather.com for weather and local news. The MY trend has dominated the Internet platform since the late 1990s and most of the well-known Internet companies, such as Yahoo!, Lycos, Infoseek, AOL, Alta Vista, and even the State of California Web site offer MY-type portals on their Web sites.

The technology for Web portals is neither new nor complicated. It requires only so-called *basic* authorization. Each user is authorized based on a user ID and a password and they can access their personal profile based on the correct user ID and password pair. Compared to domain name authorization, IP range authorization, and client digital signature authorization, basic authorization is what the name suggests. However, basic

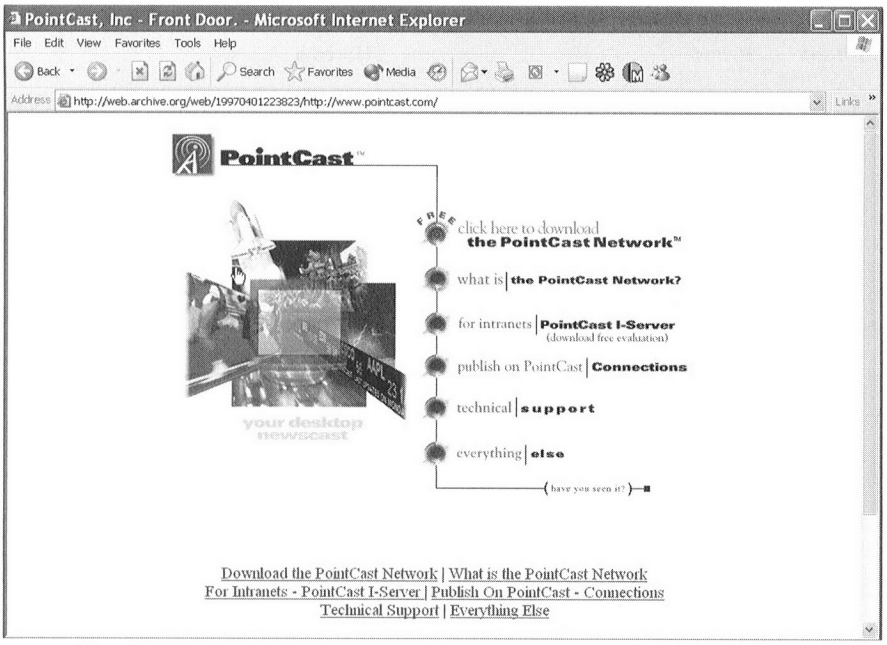

Figure 2. April 1997 PointCast Web Page (Archived)

authorization remains one of the most secure methods to preventing unauthorized access. The system resource requirement for setting up Web portals is minimal as each personal profile is very small; the space required on a Web server for even 50,000 personal profiles most often can be handled without additional hardware. It is interesting to note that Web portals or user customization are rarely mentioned in any computer science or electrical engineering journals. Most technical manuals for Web design and maintenance do not even bother with an index entry for portals. The author spoke several times with a senior enterprise system administrator for Intel's research division (see acknowledgment), where portals have been used heavily on the company's intranet. The Intel system administrator was surprised to learn that Web portals were still a research topic in higher education. For computer system administrators, the Web portal is merely a business process to improve the efficiency of company workflows, similar to the concept of an index to find information in a library. It is not surprising to learn that Web portals are frequently mentioned in business, education, and library and information science journals, but rarely mentioned in computer science and electrical engineering journals or in any Web site design technical manuals or handbooks.

The term "portal" is relatively new in the library field, and Web portals did not become an independent entry in *Library Literature and Information Science* until 1999. Library portal practice first appeared in January 1998 at the North Carolina State University Libraries.[9] The MyLibrary portal (my.lib.ncsu.edu) was truly a pioneer among academic library Web sites as it allowed individual users to customize the Web page by category. During the American Library Association (ALA) Midwinter Meeting in January 1999, the experts of the Library and Information Technology Association (LITA) identified the library portal as one of the future trends for library technologies.[10] This trend of Web customization remained the LITA top trend for the 2000 and 2001 ALA Midwinter Meetings.[11]

In September 1999, more than eighty research academic library directors came together to engage in a series of discussions and working sessions at the ARL/OCLC Strategic Issues Forum for Academic Library Directors in Keystone, Colorado. These discussions created the Keystone Principles. The term *library portal* did not appear in the document, but the portal concept was embedded in two of three Keystone Principles: "Principle Two—Libraries are responsible for creating innovative information systems for the dissemination and preservation of information and new knowledge regardless of format" and "Principle Three—The academic library is the intellectual commons for the community where people and ideas interact in both the real and virtual environments to expand learning and facilitate the creation of new knowledge."[12]

In December 2000, *Information Technology and Libraries* published a special issue on user-customizable library portals, and it stated clearly that user-customization was the key for library portals.[13] However, unlike commercial portals, library portals did not proliferate after the pioneering stage and there were only a dozen library portals at the end of 2002. Will the portal become the next generation business model for libraries like the online catalog in the 1980s and the static Web of the 1990s?

The answer is, "it depends." For academic libraries, as they are only one unit among their parent organizations—universities or colleges—it is unlikely that libraries will develop portals if their affiliated universities do not. Even if the university adopts a portal approach as its new business model for future Web development, the academic library is more likely to be included in the university portal as it is not logical to have more than one portal for each university. By the

end of 2002, only a few dozen universities had implemented Web portals according to Eisler's report in Syllabus (www.syllabus.com).[14] Many universities, government education agencies, and commercial Web technology providers published numerous white papers or guidelines on higher education portal development. Campus portals are out of the scope of this article, but the author recommends two books for further information: *Designing Portals*, edited by Ali Jafari and Mark Sheehan, and *Web Portals and Higher Education*, sponsored by Oracle Corp. and KPMG Consulting.[15]

To apply the various guidelines discussed in these two books on academic libraries, the author developed the following academic library portal development principles:

- The academic library portal platform should be the same as the campus portal
- The library portal should be developed iteratively—start small, but each portal product should be a building block for the next one
- The library should be sharing the same central users database with the campus (the campus has all faculty, staff records from payroll, and student records from registrar, while the library has community users records that the campus does not have)
- The library portal should be integrated with campus Web portals or have the capacity to be fully integrated in the future
- The library portal should include courseware tools for faculty and students and incorporate the library's major public services into course design
- Academic library portal development should consider revenue generation and fund-raising; the portal design should allow for advertising and e-commence for alumni and community members if desirable and appropriate

One point worthy of explanation is the iterative process. Iteration is the

repetition of a process where the results from one or more stages are used to form the input to the next process. It is a fundamental mathematical method for computing. To build portals iteratively means the process of building 1 through n stage portals can be used as the basis for building n+1 stage portals. Many of the pioneer academic library portals were developed before their affiliated campus developed university-wide portals. There were also plenty of articles and presentations on academic library portals. However, if library portal development does not follow some well-planned guidelines, the existing library portals will be short lived.

Four basic approaches exist for creating academic library portals: building a portal, joining a campus portal, partnering with other academic libraries for portal development, or hiring a portal vendor. Due to the limited scope of this article, the author is only focusing on the first approach, building a portal for an academic library, and almost all examples cited later in this article are home-made library portals. For participating campus portal development, David Eisler, the provost at Weber State University, presented an overview of building a campus portal to connect all the institution's constituents.[16] The major concern for librarians among recent campus portal development was that the university library was often not represented in planning campus portals. Campus portal planning usually involves campus IT, business operations, and public relations, but it should also involve the university library as a major information provider. Library consortia have handled license fees for electronic library products for member libraries and negotiated with commercial publishers as the *big buyer* for many years. It is more economical for library consortia to continue as a big buyer in library-portal development. One problem with the consortia portal approach is the difference in access privilege among different member libraries, and that may be why there has been a lack of consortia portal development. For selecting library portal vendors, Boss has an interesting article posted on the Public Library Association's Web site in which he discusses sources for portal vendors and their integration with library automated systems.[17]

The cost of building an in-house portal varies depending on available resources in the library. Many university libraries already have their own Web servers, application server, database products (MS Access, SQL, or Oracle) and enough storage space for each user to create a small profile. The major costs will be staff resources to create the My.Library portal and to maintain it. The construction time is normally six to twelve months for a complete My.Library site. Most academic library portals are not built from scratch, and many scripts are becoming freely available on the Web. It is the author's prediction that by 2005, either packaged My.Library software will be available free on the Internet for academic libraries, or commercial vendors will offer My.Library as a module for academic libraries to purchase.

Other than the dozen or so who adopted Web portals, the majority of academic library Web sites in 2002 and 2003 were either *hierarchical* or *audience orientated*. The hierarchical Web is a copy of a library's physical hierarchical structure, mainly organized by divisions (public service and technical service), departments (reference, access service, acquisition, cataloging), and units (interlibrary loan, reserve service). The audience Web site is organized by user types, such as faculty and staff, current students, prospective students, alumni, friends, and donors. Many libraries have combined the hierarchical and audience Web structures for their home page. The portal library Web site can be a build-in function in either hierarchical or audience library Web site. While library Web portals will provide different information for different users, the general My.Library portal contents are illustrated in figure 3.

Some of the pioneer academic library portals discussed in the following section are pioneers in the sense that their campuses did not have Web portals when these libraries took the lead and developed their own library portals.

Personal News	New books, articles, and reserve materials related to the predefined personal profile
Communications	Message from subject librarian for reference question. Other notifications, such as book overdue, ILL book due, etc.
Personal Records	Books checked out, ILL or new book requests status, pay dues or fee based document delivery online with credit cards
Calendar	Exhibition schedules, library cultural and art programs
E-Learning	Library catalog, networked databases, ILL and other document delivery service, e-reserves
Online Community	Alumni chatting, life-long learning, donors recognition, and Friends of the Library forum
Channels	New library services, library hours updates, special collection's new exhibition, student employment opportunities, best-selling books now in the library
Other	Online fundraising, possible book donations, and other revenue generating functions

Figure 3. My.Library Web Portal Contents

- MyLibrary @ NCState (http://my.lib.ncsu.edu) is the first academic library portal and a great prototype (see figure 4). There is a guest account for non-university community members to see the portal page. The background information and some scripts are available to the public at http://dewey.library.nd.edu/mylibrary.
- Virginia Commonwealth University Library (www.library.vcu.edu/MyLibrary) allows users to choose information resources with some predetermined information based on users' disciplines. It also allows guest log-in (see figure 5). Background information is at www.library.vcu.edu/mylibrary/about.html.
- MyLibrary at Mississippi State University (www.lib.usm.edu) is an example of low-cost library portal approach. In 2000 Li Zhou, a graduate student in the computer science department, designed the Mississippi State University MyLibrary project as a partial fulfillment of her master's degree requirements. Another unique feature of this Web site is the additional MyCourse portal for instructors on the library home page.
- The University of Washington's My Gateway portal (www.lib.washington.edu) is a prototype for large research library portals (see figure 6). It provides a guest page for people outside the university community to see the interface.
- The library portal at Spencer S. Eccles Health Sciences Library at the University of Utah (http://medstat.med.utah.edu/library/personalize.html) is an example of a special library portal. From the main library Web page, a button labeled *Personalized Eccles* will lead users to the portal page. Detailed instructions on how to use the portal are available in Microsoft Word and PDF formats from the library Web site.
- The University of Toronto Libraries my.library portal page (www.library.utoronto.ca/mylibrary) has multiple functions. The portal is the personal library Web space where University of Toronto community members can collect e-journals, library materials, catalog searches, Web sites, and any

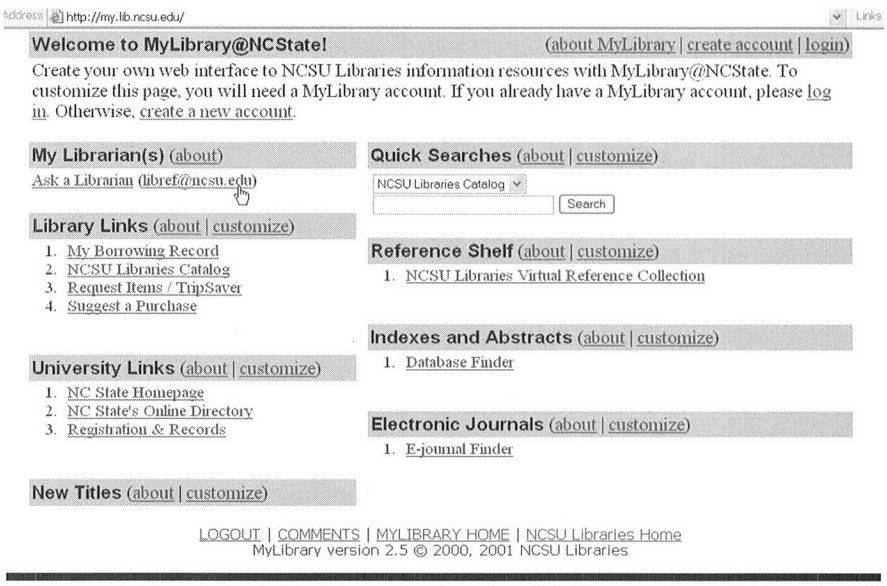

Figure 4. North Carolina State University Library MyLibrary Portal

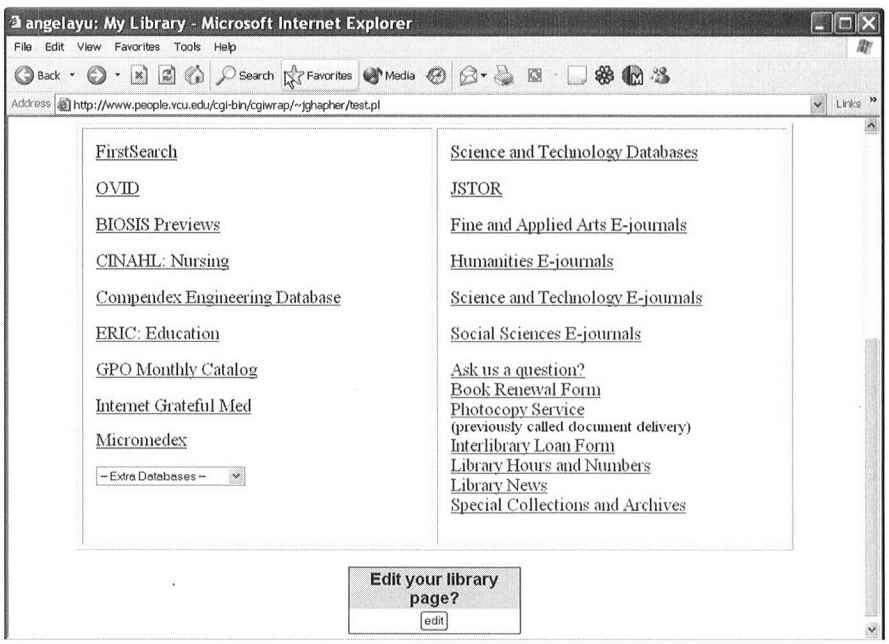

Figure 5. Virginia Commonwealth University Library Portal

other resources they choose. Faculty can also use my.library to create online resource guides for their students. A component of my.library, my.alert can be used to store canned search profiles customized to different research interests. Users get weekly updates of what's new in research within their subject areas. These updates are available in the users' choice of formats. The Publish a Research Guide function allows librarians or faculty to produce Web subject guides for students using a Web template.

Library Web portals are not inventions without problems. Crawford stated in the April 2002 issue of *American Libraries* that there are potential social problems for library portals; namely confidentiality, solipsism (user's narrowly defined profile limits the full use of library resources), irrelevance (small percentage of users make significant use of MyLibrary portal pages), and differential service (users who didn't setup a portal profile receive lower-quality service).[18] These are all legitimate social concerns about Web portal technology. However, throughout history, most technology breakthroughs have had social and economical impacts on society, and Web portal technology is no exception. As long as the community is aware of the potential impact, the problem can be dealt with accordingly.

In addition to academic library portals, public library portals are also starting to gain recognition. One good example is the Finnish Networked Public Library Services (FNPLS).

On September 22, 2000, a new and improved version of the Finnish public library portal (www.publiclibraries.fi) was launched that provides quality service as a starting point for all Internet users, especially users seeking information about libraries, children's resources, culture, and information services. FNPLS provides a login for each user with very limited customization, but users can access information in all nineteen participating regional and central libraries.

What was essential to this effort is that all public libraries in Finland participate directly in the development and maintenance of the services. Each public library has been assigned a super-username and a password in order to access the updating modules of services from workstations in their own local libraries. All the services provided by the FNPLS Web site are aimed at both library staff and the general public. Published in three languages—Finnish, Swedish, and English—each language version has its own domain name.[19]

Another portal worth mentioning is my.ca.gov, the official State of

California Web site. My.ca.gov was contracted out to a system integrator, Deloitte and Touche Consulting Group, in July 2000 and completed in January 2001. The portal site uses the BroadVision One-To-One Enterprise as the foundation, BroadVision InfoExchange Portal as the interface, Interwoven's TeamSite for content management, Broadbase Software for customer relations management, and Verity for information retrieval. My.ca.gov offers users, consumers, and contractors a single access point for all state government information and services (see figure 7).

Not all the information on my.ca.gov page can be customized. The two narrow columns on each side are fixed; only the middle column can be customized by the individual user. Under the my.ca.gov portal, companies can execute financial transactions with state agencies and individuals can file state income tax, check tax refund status, renew an expiring professional license, or renew their motor vehicle registrations online. Putting these high-demand services online is time saving for customers and state employees. The state also receives additional revenue by charging an extra online fee per transaction (for example, a four-dollar fee for an annual renewal of a personal-use class C vehicle). This is a win-win situation for all. According to Knight-Ridder, the cost of building the California State Government Web portal was initially estimated at $5 million in July 2000, but the actual costs soared to more than $10 million by the time my.ca.gov was announced by the California governor in January 2001.[20] However, the six-month construction of the my.ca.gov portal was considered speedy for the size, quality, and depth of the Web site.

The newest business model for Web pages is a *vortal*, or vertical portals. The Webopedia defines vortal as "a portal Web site that provides information and resources for a particular industry. Vortals are the Internet's way of catering to consumers' focused-

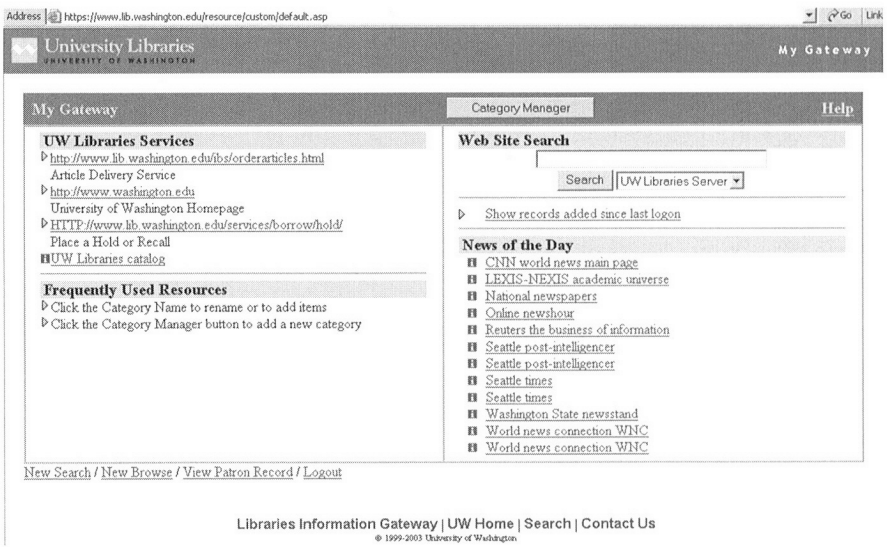

Figure 6. University of Washington Library Portal

Figure 7. State of California Web Portal

environment preferences."[21] Peter Jasco, digital librarianship columnist, wrote a very comprehensible article about portals and vortals in the February 2001 issue of *Computers in Libraries*.[22] Some examples of vortals are verticlenet.com, garden.com, web md.com, kidshealth.org, findlaw.com, and women.com. What distinguishes a vortal from a portal is its clearly defined user-centered focus in a subject hierarchy. For librarians, a vortal can be defined as a portal that organizes information in a hierarchical subject structure. The Library of Congress and the Dewey Classification Systems in a customizable Web format are perhaps the best examples of vortals.

Vortals require no search engine.[23] While this is a hard concept for computer professionals to accept, librarians have used the card catalog and library classification systems without the aid of search engines for more than one hundred years. It is not surprising to librarians that vortals can provide information without a search engine, especially if computers perform the classification in a logical and consistent way. Currently, any successful information service depends on two inseparable parts—the optimization of the search engine and the normalization of the data structure. In the last several hundred years, libraries were primarily building hierarchical data structures either as Dewey, LC, or patent classification systems without any efficient search engines. Since 1992, the Web business communities have primarily been working on building fast search engines for information retrieval without paying too much attention to data structure. Now with the exponential growth of data on the Web, it is time for librarians and Web engineers to work together to improve both the search engine and hierarchical data structures for more effective and efficient information service.

Here is a final comment about vortals made by Alan M. Meckler, CEO of internet.com in March 2001:

> The whole Internet is moving towards vertical Web sites. The Internet is so big, so wide ranging, and it's growing exponentially. No horizontal Web site can keep up; therefore, you have to go vertical. It's like a great library. Libraries have subject areas, and that's exactly how the Internet is breaking out.[24]

Library subject areas refer to library subject classification systems for information storage. While libraries strive hard to become more like business Web portals, Internet business communities also attempt to become more like libraries by organizing huge amounts of information into hierarchical structures.

Acknowledgment

Many thanks to my dear wife Min Yang, a senior system administrator at the Intel Corporation, for her explanation of Intel portals on the enterprise intranet. Librarians and IT people share many common concerns. For example, one of the major challenges for large corporation systems is computing resource sharing, or system load sharing for CPUs, memories, and file storage. If anyone is interested in computing resource sharing, please contact Min Yang directly at min.yang@intel.com.

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