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Building an Integrated User Interface to Electronic Resources

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Client/server computing and the adoption of the World Wide Web make it possible for academic libraries to build a new generation of automated library systems that present locally mounted and remote resources through a common interface. This article recounts the issues and technologies encountered by the Iowa State University Library as it undertook this process, with particular emphasis on the integration of Z39.50-accessible databases with Web technology.

With the ready availability of hundreds of electronic databases and thousands of Internet resources, it is no longer enough for an automated library system to consist of an online catalog and a handful of citation databases available over a campus network. Rather, an integrated approach is called for to allow access to a broad range of electronic resources through a common interface and to provide sufficient descriptive information online to guide users in the selection of appropriate resources. Large academic libraries have been in the forefront of building the new generation of library systems with components drawn from client/server computing, the Internet, and information standards such as Z39.50. Above all, the World Wide Web has made it possible to build an integrated user interface to electronic resources, which combines descriptive and computer-based training materials with access to a carefully chosen set of bibliographic, full-text, and Internet resources.

At the time the Web achieved worldwide attention in 1993 with the release of the Mosaic Internet browser, academic libraries had long been planning significant changes to their automated library systems. These changes were in response to a major transition taking place within computing in general. The centralized computing environment, characterized by large mainframe computers and networks of dedicated terminals, was giving way to a distributed computing environment, characterized by client/server computing products and networks of widely distributed database servers. In particular, the linkage of library systems to the Internet and the maturation of the Z39.50 protocol offered the prospect of accessing an ever-increasing array of bibliographic and full-text databases through the local automated system. Databases would no longer have to be mounted locally, but could be accessed over the Internet from library service bureaus or through consortial agreements with other institutions. The greatest benefit of Z39.50 was that it offered the potential of directly searching any database through the local systems interface. Users no longer had to adapt to another search system and its accompanying set of screens when they accessed a remote catalog or other database. All could be approached through a single interface. This ability to directly link users with resources that represented different computing platforms reinforced the attractiveness of the Z39.50 protocol for libraries engaged in linking interinstitutional or multivendor systems.

Client/server computing also offered the potential of using less costly and more interchangeable hardware components, greater flexibility in software development and database design, and the ability to incorporate up-to-date graphical user interfaces. The sum of these advantages led some of the major library automation vendors to launch development efforts for a new generation of library management systems. These systems, which employed, for the most part, relational database technology, were designed to eventually supersede the mainframe- or minicomputer-based library management systems of the 1980s. As interest in the new generation of library systems grew on the part of major academic libraries, vendors started scaling them up to handle the multimillion record databases and heavy transaction loads characteristic of such libraries. Libraries that were engaged in rebuilding their information systems through Z39.50 and client/server computing were also attracted by the developing Web technologies because they offered the prospect of linking the various technological components with a degree of integration unimaginable even three years earlier.

While there are many approaches to the process of integration and while different institutions have addressed them in different ways, the introduction of Z39.50 capability is an essential step because it facilitates the further integration of electronic technologies. The Web can then be used to integrate a variety of Z39.50 bibliographic resources into the growing number of other types of Internet resources. Despite alternative routes to the establishment of an integrated user interface to electronic resources, there are sufficient common threads in all of these routes to justify documenting the steps that one academic library, that of Iowa State University (ISU), took and the corresponding issues that it faced in establishing an integrated user interface for its automated library system.

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The Library's Databases: From Mainframe to Unix Server

In 1993 Iowa State University Library decided to convert its automated system to a client/server environment and designed a graduated conversion plan to be implemented over the next few years. The first step would be the installation of Z39.50 capability on the existing mainframe's NOTIS Library Management System (LMS). The second step would migrate index databases from the mainframe to the Unix environment. The third and final step would convert the library management system to a Unix environment. This gradual process would enable the library to learn how to manage elements of the client/server environment before it engaged in the most complex and difficult step, the transition of the library management system. It would also enable the costs of the transition to be spread over several fiscal years, thereby lessening the impact on the library's budget.

To implement the first step, the library installed a Z39.50 module called PACLink on its library management system. The library management system was running on a Hitachi Data Systems mainframe under IBM's operating system software (MVS, CICS, and VTAM). PACLink is a NOTIS product that acts both as a client and a server. As a client, it enables remote online catalogs and citation databases to be made available to local users through the familiar terminal interface. As a server, it allows the ISU online catalog and citation databases running under the NOTIS Multiple Database Access System (MDAS) to be accessed by other systems that have Z39.50 capability. When first installed in early 1994, PACLink provided access to three remote online catalogs located at Indiana University, the University of Iowa, and the University of Minnesota, and to one citation database (ERIC) located at the University of Iowa.

The implementation of PACLink showed that the mainframe could be adapted to the client/server environment in a limited way. Technological trends indicated, however, that Unix-based servers would provide even more efficient database access. Responding to these trends, and seeking to sustain a gradual transition, the library decided in late 1993 to install the NOTIS Z39.50 server software, InfoShare, on an IBM RS/6000 computer running under AIX[1] and to migrate the citation databases that had been running on the mainframe's MDAS module.

AGRICOLA, a major index of agricultural literature, was the first database to migrate to the new platform. The ISU library, as the lead institution in a federally funded project,[2] had agreed earlier that year to provide access to AGRICOLA for a consortium that included ISU and three other major research institutions (Indiana University, the University of Minnesota, and the University of Wisconsin–Madison). Running AGRICOLA under InfoShare software promised to be a good test of the viability of remote access to Z39.50 servers over the Internet. In early 1995 access to AGRICOLA via Z39.50 was implemented. It was followed a few months later by Biotechnology Abstracts. Later, once the procedures for consortial access were regularized, the University of Iowa obtained access to AGRICOLA under another consortial arrangement with ISU. Thus, in addition to testing Z39.50 access over the campus network, the ISU library was able to coordinate the testing of remote access to AGRICOLA by four major research institutions in different states.

The success of this effort prompted the library to continue the migration of citation databases from the mainframe to the InfoShare environment. By the summer of 1996 the seven H. W. Wilson indexes, which are heavily used by ISU's undergraduates, were moved to InfoShare.[3] This meant that all citation databases, which had run under MDAS on the mainframe and had been accessible through its terminal interface, could now be accessed via Z39.50 protocols from another server.

This left step three, the conversion of the NOTIS LMS to a true client/server environment. This conversion poses major challenges for the library because of the complexity of library processing activities in acquisitions, cataloging, and circulation. The mainframe NOTIS LMS, with its bibliographic database of almost a million records, has served the library effectively for six years. A client/server replacement system must function on at least the same plane. Because most existing client/server products are not yet fully developed to meet the needs of a large academic library, ISU is proceeding cautiously by monitoring the progress of Ameritech Library System's Horizon and similar products of other vendors. The opportunity to provide technical support for a federally funded library automation project of the State Library of Iowa[4] is facilitating the ISU library's evaluation effort by giving it firsthand experience with how Horizon handles a large bibliographic database of almost three million records.

First Steps to Building an Integrated User Interface

At the end of 1993, when plans to implement a client/server environment were well advanced, although not completely realized, the explosive growth of the World Wide Web opened the possibility of a universal integrating environment through which access could be

provided to Z39.50 databases and other types of electronic resources. Since much of the impetus for the adoption of this technology was coming from outside the library profession, libraries had to learn how to adapt their systems to the larger information environment. Rather than being the central focus of library automation activity, Z39.50 access to library databases would now be part of a larger framework of electronic resources available over the Internet.

In mid-1993 many libraries installed Gopher clients and linked telnet programs to them to provide access to remote libraries through terminal interfaces. Although it was not obvious at the time, this was a defining experience. It established the model for a group of associated programs that could work with one another to collectively provide access to a broader range of electronic resources more effectively than could any single tool. The menuing capability of Gopher made possible online directories that could both list resources and provide pointers to them. This function had already been used in some online products, such as Hytelnet, which listed online catalogs and provided telnet access to them by means of scripts. Gopher added new levels of functionality and flexibility, but almost as soon as its possibilities were realized it was superseded by the World Wide Web.

In early 1994, as part of its federally funded grant to test information sharing interinstitutionally via the Internet, the ISU library installed a World Wide Web server. From the beginning access was provided to the library's automated system, SCHOLAR, by means of a telnet link. This echoed the Gopher model of a helper application that extended the capability of the main program. What was different about the Web environment was its ability to integrate menus, descriptive information, and resources more tightly through multipurpose documents and hypertext links. Gopher menus could only point to other menus, documents, or resources. This meant that a resource usually required two menu entries, one for the descriptive information and another to point to the resource itself. Users would proceed from the menu to the descriptive information, back to the menu, and then follow the link to the resource. A result of the strictly hierarchical framework in which Gopher operated, this proved very cumbersome. The Web, on the other hand, could use documents as menus or descriptive materials—or both at the same time—and could provide links to the resources from any word in a document. This greater flexibility meant that a user could follow a linear sequence in seeking information.

The first degree of integration of Z39.50 with the Web took place through the telnet link to the library's automated system. The telnet helper application took the user to the opening menu of the NOTIS software, which listed the databases available through the mainframe. This was the same menu seen at terminals throughout the library system and hence was familiar to a majority of users. Since some of those databases were being made available through Z39.50 links from the mainframe to remote servers, the ability to call up the library system from a Web document also represented the first step, albeit indirectly, at integrating Z39.50 with the Web environment.

As useful as this type of connection was, it was still limited to character-based databases that came through a terminal-like interface. It did not really take advantage of the hypertext features of the Web nor its ability to retrieve and display multiple media. Nor did it take advantage of the graphical features of the windowing environments available on common computer platforms. Connections were made to the NOTIS system rather than to specific databases so that users who thought they were selecting a database from a Web page had to reselect it from the opening screen of the mainframe. What was desired was greater continuity between the database descriptions of the online catalogs and index databases in the Web pages and the search interface for the databases. The next step was to link graphical Z39.50 clients to Web browsers in order to achieve a higher degree of continuity and integration.

Next Steps: Integrating the Graphical Z39.50 Client

Early in 1994 the first generation of graphical Z39.50 clients reached the marketplace. Originally conceptualized as stand-alone tools to provide a common interface for accessing a variety of bibliographic databases, the clients reflected the industry-wide migration to a graphical operating environment. They took advantage of pull-down menus, button bars, dialog boxes, and the use of a mouse—all of which promised to make the operation of complex software easier. While most clients were first developed for MS-Windows, vendors promised comparable versions for both the Macintosh and Unix operating systems.

The ISU library obtained several of these clients and experimented with executing them from the Mosaic Web browser. Although by midyear it was clear that some Z39.50 clients could be linked to Web browsers and thereby used as the vehicle for accessing Z39.50 databases, there were still obstacles. Most importantly, there was no standard way in which a Z39.50 client could be called from a Web page. Although Z39.50 version 1 had

provided the basis for WAIS, an indexing system for online databases, Z39.50 version 2 had not achieved much recognition outside of library circles. Nor were there enough products using it to provide either guidance or incentive for Web developers. Consequently, one had to treat the Z39.50 client as a helper application and define Z39.50 as a multimedia extension (MIME) type in the Web browser.

Some vendors, such as VTLS, provided helpful information that facilitated linking their client to the browser.[5] Others, however, did not allow the use of parameters to select specific databases at the time the client was launched, and instead brought up their own menus from which users could select databases. For example, the first Ameritech Z39.50 client, ProPAC, had its own menu selection screen, which, in effect, replicated the menuing system of the NOTIS LMS Navigator. A subsequent version of this product, WinPAC, overcame this limitation by using a separate configuration file for each database and allowing connection to a specific database by passing the name of the configuration file as a parameter when the program was executed.

Initially none of the clients allowed links to local holdings information in the online catalog from citation databases. As this was an important feature of the NOTIS mainframe software, Ameritech introduced it in later versions of WinPAC. Unfortunately, this feature functioned only when WinPAC was used with its own menuing system, not when it was started with a specific database configuration file. This limitation was one indication of the difficulties that vendors were having in redesigning their products to take advantage of linking the Z39.50 environment to the Web.

The first generation of Z39.50 clients had other problems as well. Some did not function well on a local area network (LAN), which was required by the ISU library's use of Novell Netware LANs to run both staff and public applications. Some Z39.50 clients put considerable demands on available resources, especially when they ran on top of a Web browser. In some cases, Windows would slow down to an unacceptable crawl even on a 486DX machine with 8 MB of RAM.

Even though there were technical problems to be overcome, it was clear that the marriage of a Z39.50 client to a Web browser would be a major enhancement in public workstation functionality. After considerable discussion between the summer of 1994 and the spring of 1995 the ISU library decided to introduce experimental public workstations based on this model in the main library and in various reading rooms. A couple of years earlier it had planned on supplementing and eventually replacing terminals with PCs running a Z39.50 client. With the integration of Web and Z39.50 technologies, a much bolder vision of the public workstation took shape. The Web could now be used to identify, describe, and provide links to library-selected bibliographic resources of all types, in addition to Internet resources that were beginning to appear in significant numbers.

This reconceptualization was reflected in the term "SCHOLAR Workstations," which was applied to the experimental public workstations. SCHOLAR had been the name originally applied to the local online catalog when it first appeared in the late 1980s. After the automated library system was converted to NOTIS in 1990 and index databases were added via the MDAS module, the online catalog was renamed ICAT and the term SCHOLAR was applied to the entire online system. As Z39.50 resources were added to the mainframe interface through the PACLink module, SCHOLAR continued to be used to refer to the entire body of online catalogs and index databases, even though some of them were now accessed from remote servers. In 1995 the term SCHOLAR Workstation was coined. It identified not only a mechanism for accessing the SCHOLAR system, but the array of locally mounted bibliographic resources and remote Internet resources selected by the library for its users and represented in its Web pages.[6]

While the databases on the mainframe, the online catalog, and the seven Wilson indexes constituted the core of bibliographic databases available to users at the time that the SCHOLAR Workstations were set up, Z39.50 accessible databases were available from several other servers. AGRICOLA and Biotechnology Abstracts were on the ISU InfoShare server, ERIC and Current Contents ran under MDAS on a mainframe at the University of Iowa, and direct connections were made to the online catalogs of five regional academic institutions (Indiana University, the University of Iowa, the University of Minnesota, the University of Northern Iowa, and the University of Wisconsin–Madison).

To provide context for library users, the library's Web pages described the nature and scope of the resources as well as provided links to them (see figures 1 and 2). These descriptive statements derived from a long-standing tradition of providing printed guides to library resources and were easy to adapt to the online environment. At first two types of connecting links were made available. One involved a terminal-like interface through a telnet program. This was essential to provide a comfort level for users who were not ready to try a graphical Z39.50 client. The second interface was Ameritech's Z39.50 client, WinPAC. When parameters from a Web page were passed to WinPAC, it started up and connected directly to the desired database, thereby avoiding the opening database selection menu. Users could start their searches immediately and could conduct all searching and record displays entirely within a graphics-oriented Z39.50 environment.

IOWA STATE UNIVERSITY LIBRARY

ISU Online Catalog (ICAT)

ICAT is the Iowa State University Library's Catalog, and can be used to locate books, serials, and other materials owned by or on order for the Library. Currently ICAT contains records for over 949,000 items: approximately 90% of the books, microforms, media, music, and archival materials and all of the cataloged serials (i.e., magazines, periodicals, journals, etc.) in the Library. Materials not in ICAT include: many government documents; sheet maps and aerial photographs; many rare, archival and manuscript materials; photographs; most ISU theses, 1877-1930; and college catalogs. ICAT can be accessed through a variety of interfaces, each with its own features and capabilities.

- Connect to ICAT using the new, simplified graphical Web interface.
- Connect to ICAT using the standard graphical Web interface.
- Connect to ICAT using a character-based terminal interface.
- Connect to ICAT using a character-based IBM 3270 terminal interface.

ICAT Tutorials

If you'd like to learn more about the terminal interface, the following tutorials demonstrate beginning and advanced techniques. (These are *not* the Library 160 tutorials.)

- Run ICAT Beginning Tutorial *(library only)*.
- Run ICAT Advanced Tutorial *(library only)*.
- Download ICAT Beginning Tutorial *(ISU only, MS-Windows)*.
- Download ICAT Advanced Tutorial *(ISU only, MS-Windows)*.

More Information about ICAT

- SCHOLAR Fundamentals: Basic Online Public Catalog Searching
- Statistical Snapshot of the ICAT Database
- Call Number Locations in the Parks Library General Collection
- Subject authority records
- Frequently asked questions
- SCHOLAR Newsgroup.

Return to: ISU Library Home Page | ISU Library Web Search

Comments: *jvc@iastate.edu*
Iowa State University Library, Ames, IA 50011
URL: http://www.lib.iastate.edu/scholar/db/icat.html
Revised: 06 January 1997.

Figure 1
ISU Online Catalog

IOWA STATE UNIVERSITY LIBRARY

AGRICOLA

The AGRICOLA database (AGRI), produced by the National Agricultural Library, provides access to more than 3,300,000 citations in the agricultural literature including agricultural economics, animal culture and welfare, biotechnology, human ecology, soil science, and veterinary medicine. AGRICOLA indexes articles, books, theses and patents dated 1970 to the present. AGRICOLA can be accessed through a variety of interfaces, each with its own features and capabilities.

- Connect to AGRI using a graphical Web interface.
- Connect to AGRI using a Windows-based client interface *(library only)*.
- Connect to AGRI using a character-based terminal interface.
- Connect to AGRI using a character-based IBM 3270 terminal interface.

New! Off campus access to this database is now supported for the ISU community.

Return to: ISU Online Catalog (ICAT) | Indexes and Abstracts | ISU Library Home Page | ISU Library Web Search

Comments: *gerrymck@iastate.edu*
Iowa State University Library, Ames, IA 50011
URL: http://www.lib.iastate.edu/scholar/db/agrixx.html
Revised: 31 December 1996.

Figure 2
AGRICOLA

Integrating Additional Resources

With the integration of Z39.50-accessible databases and the addition of selected Internet resources to the library's Web pages, the Web environment was taking shape as a powerful tool to suit the instructional and research needs of library users. However, there were additional electronic resources, such as the CD-ROMs that were mounted on the library's LAN, that were still inaccessible. Shortly before the SCHOLAR Workstations were implemented, the systems staff discovered a way to provide access to the CD-ROMs. The library acquired a program written by Will Sadler of Indiana University that would launch DOS and Windows programs from a Web browser. After some experimentation, the Launcher program was configured to work successfully with all of the proprietary applications that accompany the library's CD-ROM databases. If a MIME type for launcher files is defined in the Web browser, the file directs the Launcher program to execute the appropriate DOS or Windows program. Since the library was running primarily DOS applications on its LAN, the Launcher program was used to run the batch files that are used to map and unmap CD-ROM drives as well as execute the applications. This new functionality enabled the library to provide direct access to sixteen additional databases from the SCHOLAR Workstations located in the library. While it did not overcome the problem of accessing CD-ROMs over the Internet (workstations have to be logged onto the LAN where the CD-ROMs are located), it extended the integrating capability of the library's Web pages.[7]

One outcome of the effort to access CD-ROM applications via a Web browser was a better understanding on the part of reference and other library staff of the limitations of the LAN. Having databases on the LAN is

very effective within the confines of the library system, where staff have responsibility for the setup of the computers used by the public. However, providing access to the LAN from outside the library requires that users log into the library's Novell server and run the search interfaces from it. On a campus with highly distributed responsibility for the setup and maintenance of multiple computer platforms and network protocols, it is impracticable to provide access to online resources by requiring users outside the library to sign onto a Novell network and use a single computer platform (PCS). Client/server technology, on the other hand, is much more amenable to the wide area distribution of online resources in a heterogeneous computing environment. With the implementation of the Web as the linking mechanism, online resources can be presented and accessed through a single environment irrespective of user platform.

As the library staff came to understand the implications of the client/server environment, that understanding led to a decision to review the resources available on the LAN and, ultimately, to migrate heavily used or especially important resources to a client/server platform so that they would be more widely accessible. By early 1997 a total of eight index databases had been moved over to InfoShare.[8]

Another benefit of the use of the Launcher program was that it could be used to provide access to tutorials developed by the library. Several tutorials had originally been developed in Authorware for the one-credit library use course required of all freshmen at Iowa State University. With a broader audience in mind, the library generalized the programs for any novice library user. Three of them were made available via the library's Web pages so that users unfamiliar with the process of searching and displaying records from the online catalog or citation indexes could learn how to do so at their own pace. Options were also provided for downloading the tutorials in case the users were at a workstation that could not launch them. Eventually, these tutorials will be rewritten in Java or some other programming language that will enable them to be executed on any client platform.

In addition to these resources, the library converted a number of its printed guides and handouts into hypertext mark-up language (HTML), so that users could find out more about the services and operation of the library by accessing the library's Web server. This included information about library hours, library services, and circulation regulations, as well as graphics of the library's floor plans. Pointers to campus electronic resources and the major Internet search engines were also added to the server.

One important library resource was the addition of over sixty finding aids to specialized collections. Traditionally, these had been available only by going to the Special Collections Department and browsing through them before requesting access to the materials that they described. By virtue of putting them online, it was possible for scholars to know in advance what materials they needed, thereby making library research more effective. The finding aids include container listings of the items in the collections. When it eventually becomes possible to put electronic versions of documents in special collections online, hypertext links to the documents can simply be added to the finding aids.

With the ready availability of the library's Web pages at SCHOLAR Workstations within the library and in laboratories, offices, and residences throughout the campus and beyond, the library decided to offer online services as well. Foremost among these was a mechanism for users to ask reference questions over the net. Christened "Webref," the service enabled library users to fill out an online form with their questions, which in turn generated e-mail messages to an account of a member of the reference staff, who responds to the questions. The Special Collections Department established a similar service for clientele who are interested in its nationally known archive of nonfeature films (American Archive of Factual Film). An online request form for adding materials to the library's collections is in testing and will become operational sometime during 1997.

With several hundred Web documents and several specialized services emerging, it became necessary to facilitate users' navigation of the Website itself. While the Web's ability to create horizontal links to multiple documents is a great improvement over the strictly hierarchical Gopher environment, it is still difficult for users to navigate through multiple links to find what they are looking for. To help mitigate this problem the library installed a WAIS indexing system called SWISH on its Web server. SWISH indexes all the documents on the server and is accessed through a simple search form. Links to the search form are provided from nearly all Web documents. Since the most important and heavily used resources in the library's Web pages are the links to electronic resources, the library spent some time learning how to structure the descriptions of them so that the weighting algorithm employed by the WAIS indexing system would bring them to the top of the search results.

Hypertext links were also used to facilitate navigation around the Web server. A hypertext link to the University's home page and another to the library's home page appear on nearly every document on the Web server. Thus, with one click, someone lost in what might seem to be a maze of documentation can jump directly to either home page. In addition, return statements for the chain of documents from the home page to the

current document were placed at the end of each page, thereby enabling the user to jump back to any intermediate level document.

Web Gateways to Z39.50 Databases

By the summer of 1995 interest in accessing Z39.50 databases from Web gateways was drawing the attention of librarians and vendors alike. It was seen as an opportunity to simplify access for users, who could access online catalogs and index databases directly through a Web browser without having to obtain and configure a Z39.50 helper application. It also obviated the need to develop and maintain versions of a Z39.50 client for the three major user computer platforms (PCS, Macs, and Unix workstations).

The ISU library had observed the rising tide of interest in this mode of access and, during the summer of 1995, had assigned a programmer the task of setting up an experimental Web gateway to Z39.50 databases. After a preliminary assessment of the available products, the library elected to implement the DB Connect software developed by Howard Finkbeiner of Stanford University. It offered a great deal of flexibility and was relatively simple for a programmer to adapt to library needs.

By the end of the summer the Web gateway had been implemented with access to the library's online catalog and those of five other institutions with which the library has cooperative relationships. Because many of these were NOTIS sites, a special effort was made to configure the gateway to obtain call number, location, and status information, which in the NOTIS environment are maintained outside the MARC bibliographic record.

The gateway offers users a CGI search interface that acts as an intermediary between the HTTP protocols of the Web and the Z39.50 protocol of the database servers. This allows searches to be conducted from any Web browser that supports forms. MARC records are converted on the fly into both brief and long record displays in HTML and can be displayed or printed as Web documents. Later, when access to citation databases was added to the gateway, links to the library's holdings were implemented through a secondary search of the local online catalog via ISBN or ISSN. Users could also forward citations to an electronic mail address, a function supported by most major browsers.

After the Web interface became available in the fall of 1995, the Reference Department conducted a comparative evaluation of the four available interfaces: the mainframe terminal interface, the Z39.50 client WinPAC, the Web interface, and the SilverPlatter Electronic Reference Library (ERL) client WinSPIRS.[9] The outcome of the evaluation was to select the Web interface as the default interface to SCHOLAR databases. The Web interface maintained the continuity of the Web environment and was less subject to hanging up the workstation than the Z39.50 client. It also provided a valuable link to local holdings. Planners decided to retain the terminal interface as a transitional strategy for the large numbers of users accustomed to it and because of its ability to execute complex searches from the command line. The Z39.50 client WinPAC was removed from service, while WinSPIRS continued to be supported internally in the library.

A task force was commissioned to implement these changes and to improve the appearance and structure of the entries in the Web pages. For each online resource licensed or selected by the library, the database name that appears as a heading is also used as a hypertext link to the Web search interface. A descriptive paragraph outlines the scope and coverage of the database, including a hypertext link to a document that describes the characteristics of the different interfaces in detail. Following the descriptive paragraph are single-line entries for each of the methods for connecting to the database (sometimes as many as five). This information was specifically designed to fit onto a single screen of a PC running MS-Windows and Netscape in 640-by-480 VGA mode so that users can identify the database, read a description of it, and see all the connectivity options without scrolling (see figure 3). On most other local platforms and on PCs operating at higher resolutions this amount of information would fit well within one screen.

Future Directions

After a year of experience and testing, the library concluded that public SCHOLAR workstations had validated the utility of providing networked electronic resources under one linking structure. Users were discovering the usefulness of the library's Web pages in increasing numbers. In less than a year's time, between September of 1995 (when the Web server was reorganized and the search interface added) and the summer of 1996, usage of each of the four major sections more than doubled. The electronic resources section has consistently attracted more than half of the total traffic on the Web server and it is expected that it will continue to do so as more databases become available through it.

Much of the success is attributed to a structure that emphasizes the resources themselves rather than the

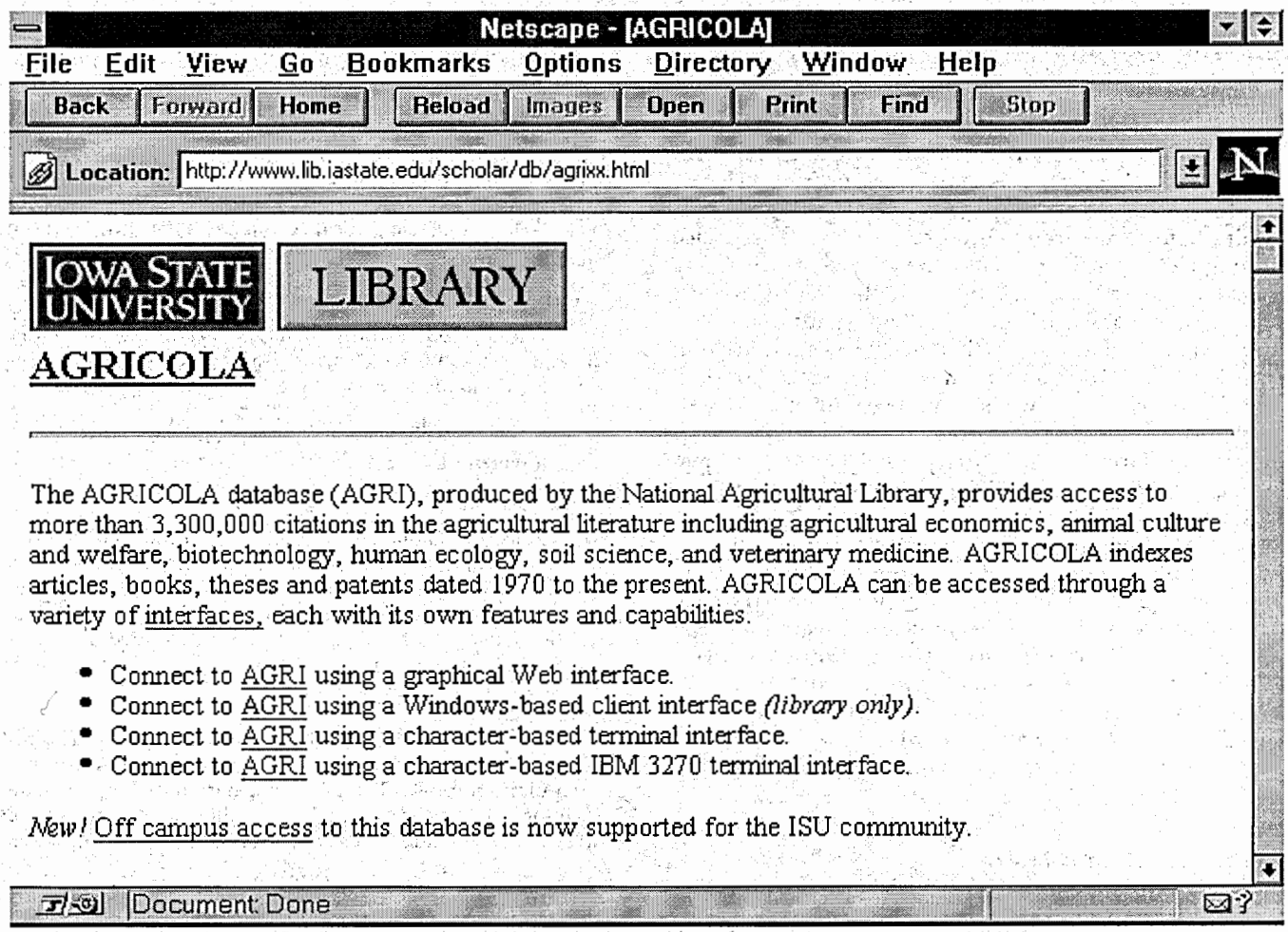

Figure 3
AGRICOLA

ways to get there or the source of the data. From the 1970s through the early 1990s libraries had to operate under the concept of "for this resource, go to this machine and use this access mechanism; for that resource, go to that machine and use that access mechanism." As a matter of practicality they have frequently identified such resources by the service from which they are available, e.g., FirstSearch or DIALOG. All of this has tended to emphasize the access mechanism or the service at the expense of the resource. By comparison, the Web allows the library to push many of these issues into the background and to put the focus on the resource. It also gives the library a flexible structure on which to build and add electronic resources without significant reengineering of its user interfaces.

The next stage in making electronic resources available will focus on full-text materials. While a number of full-text resources have been available over the Internet for some time, this stage will involve the library in mounting full-text resources locally. Two projects are in the early stages of implementation, and the Web environment will provide access to both of them. In one, reserve materials for a selected number of courses will be scanned into portable document format (PDF) documents and made available to campus users from the library's Web server. In the other, electronic versions of about 120 Elsevier Science journals will be made available on a Z39.50 server to a target audience of scholars and researchers. Both pilot projects will focus on analyzing the problems and issues of electronic document access and delivery in a large academic setting. This will help the library both plan larger scale efforts in the future and explore ways of integrating electronic texts with the bibliographic databases that have been the mainstay of the library's automated system up to this time.

Conclusion

The process of migrating from a mainframe-oriented library automated system to a client/server environment is a long and complex one. However, the main feature of such a process is a shift in focus from a single-platform-does-everything mode (the mainframe) to a multiplatform environment, where access takes place through a common interface (the Web). Critical to the success of this transition is the use of the Z39.50 protocol for the search and retrieval of bibliographic records and full-text documents. In less than two years since the Web appeared as the dominant new force in computing, Z39.50 to HTTP gateways have been developed and proven successful in linking the two technologies. What future developments will bring is unclear at this time, but it is to be hoped that Z39.50 support will be embedded into core Web technology.

Even more than in the past the transition of library automation systems to client/server technologies reflects changes in the overall computer industry. The benefit to users is that they can use software that they are using for other purposes to access library resources. The benefit to libraries is that they can concentrate on structuring an array of information resources appropriate to their user communities from a wide variety of locally mounted and remote databases and services.

References and Notes

1. As originally installed, InfoShare ran on an RS/6000 model C10, which is a single processor machine. In early 1997 InfoShare and its databases were moved to an RS/6000 model J40 with four processors.

2. "Application of Knowledge Management Concepts to the Interdisciplinary Area of Biotechnology," U.S. Department of Education, HEA Title II-D Project #R197E20003/92.

3. This included Applied Science and Technology Index, Biological and Agricultural Index, Business Abstracts, General Science Index, Humanities Index, Reader's Guide to Periodical Literature, and Social Sciences Index. Prior to 1994 these databases had been mounted as CD-ROM products on the library's LAN. In the spring of 1994 they were moved to the MDAS system running on the mainframe.

4. "A Statewide Information Network for Iowa," U.S. Department of Education, HEA Title II-B Project #R039C40011.

5. Vinod Chachra and Todd Perry, "Interfacing NCSA Mosaic and a Z39.50 Client," printed for the Coalition for Networked Information Spring Task Force Meeting, April 5–6, 1994.

6. Jerry Caswell, David Gregory, and Olivia Madison, "The University Library's SCHOLAR System: Looking to the Year 2000," *Computation Center Newsletter* (Iowa State University) 29 (July 1995): 1–5.

7. Since the Launcher program was introduced in 1994, two other programs have become available, W3Launch and OpenWEB Launcher. Both have additional features, including security functions, which would make them useful in public environments. All three programs are described in Larry Schankman, "Launching Programs and CDS from Web Browsers," URL http://www.clark.net/pub/lschank/web/launch.html.

8. They were AGRIS, CAB Abstracts, F & S Index (Predicasts), Food Science & Technology Abstracts, MLA International Bibliography, NTIS, PAIS International, and SocioFile (Sociological Abstracts). In addition, the heavy usage of the ERIC database made it cost-effective to mount it locally as well.

9. Jerry Caswell, "SCHOLAR in the Client-Server Environment: Comparison of Client Interfaces," unpublished report, October 4, 1995, 3 pp.; and John Hutchinson, "Database Comparisons," unpublished report [October 1995], 6 pp.