Design and Development of a Library Information Workstation

ABSTRACT

This paper describes the design and continuing development of the University of Illinois at Urbana-Champaign Library Information Workstation, which provides the primary, in-library patron access to ILLINET Online Plus, the Library's extended online public access catalog system. The automated library information resources and information processing environment are briefly described as they have influenced the design and development of the Library Information Workstation. The Library Information Workstation philosophy and approach are discussed in the context of relevant information access issues and patron needs and requirements. Features of the current Library Information Workstation implementation are then described using illustrations focused particularly on integrated access to local (resident on individual workstations) information files and an integrated end-user interface for bibliographic database searching. Ongoing development plans also are discussed briefly.
INTRODUCTION

This paper discusses general principles and precedents relating to library information workstation design and development, focusing specifically on interface and workstation development at the University of Illinois at Urbana-Champaign (UIUC) Library. The paper is divided into five sections: (a) a brief description of the ILLINET Online Plus (IO+) extended online catalog, (b) an overview of the UIUC Library Information Workstation (LIW) philosophy and approach, (c) a discussion of user searching behaviors and needs and the interface design considerations that have driven the UIUC LIW design and development, (d) an examination of the local file access capability integrated into the UIUC LIW, and (e) a detailed look at the integrated UIUC LIW interface developed to facilitate end-user searching of bibliographic databases accessed via the local BRS/SEARCH implementation.

Concurrent with the Library Information Workstation developments described in this paper, and to an extent the driving force behind it, has been the emergence of the Extended Online Public Access Catalog (E-OPAC). These developments in turn have been possible because of improvements in telecommunications technologies, computer hardware and software, and advances in the accessibility and breadth of bibliographic databases. Together these developments are allowing libraries to provide enhanced access to local and remote bibliographic resources. This is being done principally through the model of the E-OPAC (Hildreth, 1989, 1991; Potter, 1989).

E-OPACs typically provide value-added access to resources beyond the conventional OPAC such as campus or community information resources, locally created bibliographic files, locally mounted and remote periodical index databases, online bibliographic database vendors and utilities, and the OPACs of other major Association of Research Libraries (ARL) or regional libraries. One of the primary roles of the E-OPAC is to serve as a node in a campuswide information system (CWIS).

Supporting the E-OPAC have been a number of important emerging information technologies such as powerful yet affordable microcomputer workstations; optical disk and enhanced magnetic storage media; graphical and imaging technologies and standards; local, campus, regional, and national telecommunication networks; and sophisticated information retrieval search engines (e.g., BRS/SEARCH). These technologies supply system designers and developers with the tools needed to provide enhanced access within the E-OPAC environment.

The UIUC Library has incorporated certain of these technologies into the IO+ E-OPAC (Mischo, Sandore, Clark, & Gorman, 1990). The
development and implementation of IO+ has been integrally connected to the evolving UIUC LIW, a multifaceted microcomputer workstation developed in the Library to serve as a public terminal for IO+ (Mischo & Cole, 1992). The UIUC LIW is the primary means of accessing the IO+ information resources and plays a key role in integrating the multiple technologies that comprise IO+.

Specifically, the LIW provides interface, gateway, and database management software to facilitate direct patron access to IO+ resources and services. The major objectives of the UIUC LIW are (a) the integrated and largely transparent access from a single terminal to a wide range of library and information access resources, (b) the inclusion of user-friendly, expert-system interfaces that facilitate patron searching of bibliographic databases and lessen end-user searching difficulties, (c) the built-in flexibility to allow terminal-specific customization of LIW menus and interfaces to accommodate localized patron needs and library resources, and (d) the utilization of emerging multimedia and image transmission technologies to enhance end-user interfaces and to provide more rapid and more complete patron access to information.

The later sections of this paper illustrate some of this functionality with specific examples, focusing on two of the information resources available in the current UIUC LIW implementation: the capability of storing, searching, and integrating local, customized databases stored on the workstation hard disk and a microcomputer-based interface for the locally mounted BRS/SEARCH implementation IBIS (Illinois Bibliographic Information Services). These two particular LIW features serve as illustrations of the enhanced information access provided jointly by the LIW and the E-OPAC.

Finally, the paper concludes with a brief discussion of current planning and development work in progress to further extend the scope and functionality of the UIUC LIW.

**ILLINET ONLINE PLUS**

The IO+ extended OPAC provides access to a variety of local and remote information resources via two different campus networks. These resources include the following:

1. The statewide online catalog ILLINET Online (IO) with holdings data from over 800 libraries in the state of Illinois, totalling over 9 million records. Access to IO is through both microcomputer and mainframe interfaces.
2. A locally mounted mainframe-based BRS/SEARCH retrieval system (IBIS) and attendant periodical index databases, presently comprised of Current Contents (seven sections, updated weekly), eight Wilson databases (Readers' Guide Abstracts, Social Sciences Index, Humanities Index, Business Periodicals Index, Applied Science and Technology Index, Biological and Agricultural Index, General Science Index, and a combined file), and the ERIC databases. The IBIS system is presently comprised of 5.1 million periodical citations.

3. Locally generated and maintained data files stored on the microcomputer workstation hard disk and searched using a locally developed sequential search database management system. These files can be customized by departmental library site and include databases such as hot topic bibliographies, faculty interest profiles, staff directories, new book lists, and reserve lists.

4. A gateway to the CARL (Colorado Alliance of Research Libraries) UnCover periodical database system.

Additional information resources are currently being tested and integrated into the LIW at selected UIUC campus library sites. These resources include the following:

1. Gateway access to database and telecommunications resources on the campus fiber-optic network (UIUCNet), which include the Oxford English Dictionary (OED), weather information, current news, class listings, and campus telephone directory.

2. Gateway access to Internet resources, including the OPACs of selected Committee on Institutional Cooperation (CIC) and ARL research libraries and consortia, such as Northwestern University, Indiana University, and the MELVYL California statewide union catalog, and access via a local Gopher client to many other Internet resources.

3. Access to databases stored on CD-ROM networks (including full-text files such as the UMI periodical article data) using the CD vendor search engines, run from the interface using shell software.

4. Multimedia and graphical files (in .PCX format) such as building maps, floor plans, and mixed graphics, sound, and text (including hypermedia files). Software has been developed to retrieve and display scanned images with voice-over being provided by a programmable speech synthesizer.

5. The capability of invoking specific commercial microcomputer software application packages such as expert system and database management packages from the interface and returning to the interface menu level using shell software.

In addition, several important access and linking mechanisms are in place within the Information Workstation and IO+ for providing
maximum access to available information resources. These mechanisms include the following:

1. UIUCNet file transfer capabilities used to transmit BRS/SEARCH search results (bibliographic citations and abstracts) to users’ electronic mailboxes.
2. The on-the-fly linking and display of call number and limited holdings information from a displayed BRS/SEARCH search citation.
3. Software-controlled gateway paths within the workstation including automatic logon to local and remote resources and hidden password entry for applications requiring passwords.

The above information resources and linking technologies are made available to library users and staff through the LIW software, presently deployed in 39 UIUC departmental libraries on some 110 public terminals. The software is also being tested at selected institutions in the 40-member ILCSO (Illinois Library Computer System Organization) network consortium. The workstation software is also being tested in networking environments utilizing TCP/IP telecommunications protocols.

LIBRARY INFORMATION WORKSTATION

The UIUC LIW is presently implemented on a range of IBM PS/2 platforms from Model 30 286 machines to PS/2 Model 70s. The LIW employs interface, gateway, and database management software to enhance user access to local and remote information resources available in IO+. The LIW is the center of a client-server user access model for IO+ that features a distributed retrieval network with databases on local and remote file servers and the interface and gateway functions residing on the microcomputer workstation. Our implementation of this model is illustrated in Figure 1.

The information resources accessed by the LIW may reside on local or remote mainframes, on CD-ROM files in stand-alone or networked environments, or as files stored on the microcomputer hard disk and accessed via a microcomputer database management application. One of the advantages of the microcomputer workstation approach is that the main search menu presented to the user can be customized to suit the needs of specific departmental libraries. A sample main menu from the UIUC Music Library is shown in Figure 2.

The LIW project has focused on the development and testing of microcomputer software and hardware technologies to (a) enhance the user-computer interface, (b) provide expert-system searching techniques
Figure 1. Library Information Workstation: Implementation of a client-server user access model for IO+

and guided assistance in user searching, (c) utilize multimedia technologies in providing assistance with user instruction and point-of-contact help, and (d) provide extended access to information resources on the IO+ statewide network, the campus network, and the Internet.

This approach facilitates a "one-stop-shopping" approach to a broad array of information resources. The LIW is designed to use multimedia techniques in providing access to bibliographic, numerical, graphical, and full-text resources. The long-range goal of the LIW is to merge the three types of workstation technology: bibliographic database and gateway services, multimedia and imaging technologies, and scholarly user needs such as data analysis, scientific computing, and word processing.
Several academic and special libraries have pursued the development of microcomputer scholar's workstations or similar multifunctional microcomputer-based desktop systems (Arms, 1990). These institutions include Brown University, the University of Southern California, Ohio State University (Tiefel, 1991), and Carnegie-Mellon University.

USER SEARCHING BEHAVIORS AND NEEDS

In May 1990, the UIUC Library Online Catalog Advisory Committee formed an Interface Design Subcommittee with the charge to design and implement LIW interfaces, beginning with the interface to the local BRS/SEARCH implementation IBIS (Norlin et al., 1992a, 1992b). To provide context for planning the design of interface features for the LIW, the literature on user needs and searching behaviors was examined.
Numerous studies of both online catalog and end-user bibliographic searching services have been reported and reviewed (Mischo & Lee, 1987; Drabenstott, 1991; Hildreth, 1989). As Borgman (1986) has noted, the users of all online bibliographic retrieval systems exhibit similar behavior patterns and have the same types of mechanical and conceptual difficulties. Studies of direct end-user search services and online catalog use show the following:

1. Users are enthusiastic about performing searches on easy to use, quickly learned, inexpensive search systems.
2. Search strategy formulation and the use of Boolean operators pose difficulties for users.
3. Users have difficulty with the simpler interfaces provided in the after-hours services and CD-ROM systems.
5. High levels of reported user satisfaction with search results may not reflect true success rates (Ankeny, 1991; Nielsen, 1986).
6. End-user search services can demand a significant investment of library staff time in training and assistance.
7. End-users resist formal training sessions and the use of printed instructions, preferring computer-assisted instruction (CAI) and direct one-to-one instruction from library staff or peers.
8. The typical user searches relatively infrequently; even the frequent users search infrequently enough so as to require retraining or refamiliarization with the system.

In addition, the online catalog use studies have revealed several facts important to designers of E-OPACs containing periodical index databases:

1. Most catalog users want materials on a topic.
2. Subject searching is the predominant mode of searching; it accounts for more than one-half of all searches.
3. Catalog users report the most problems with subject searching.
4. One-third to one-half of searches result in no items retrieved.
5. Conversely, a large percentage of subject searches provide a partial match with controlled vocabulary terms and produce a large number of retrieved citations.
6. User-entered subject search terms match the Library of Congress Subject Headings controlled vocabulary only 20% to 40% of the time.
7. Systems with keyword searching appear to receive more subject searching.
8. Catalog users place the highest priority for improvements on various subject search enhancements.
9. Users approach online catalogs expecting to find access to a broader field of materials, including periodicals, than are covered by the traditional card catalog.

The results of the end-user and online catalog use studies have important ramifications for the design of all bibliographic retrieval systems, including OPACs, online periodical index databases, and optical disk search systems.

On the one hand, the overwhelming acceptance of E-OPACs by users and the high degree of user satisfaction with such systems can be interpreted as a mandate for enhanced subject access (Hildreth, 1987; Mathews, 1991). Historically, the card catalogs of the late 19th century provided access to periodical articles via 3 × 5 cards supplied by vendors or prepared in-house, so the renewed interest in shaping the modern online catalog into an "analytic" catalog capable of providing the same function is not surprising. Locally mounted periodical index databases provide users with access to the periodical literature from the same terminals used to search the online catalog. They serve to complement periodical index databases made available in stand-alone and networked CD-ROM workstations. Local access to the periodical literature has become a common feature of the E-OPAC (Seiden, 1991; Locally loaded databases, 1989).

On the other hand, the use studies also show that the objective quality and success of end-user searches often are not high. The interface plays a particularly critical role in the searching of bibliographic retrieval systems that employ sophisticated information retrieval techniques and contain records with subject-rich fields.

Yet, while it has become clear to library system designers that better interfaces and "front-end" technologies can greatly enhance end-user searching of today’s large bibliographic databases, examination of the information science and computer science literature reveals that there are no prescriptive models that can be followed to arrive at an optimum interface design (Grudin, 1989; Sutcliffe & McDermott, 1991; Yee, 1991). There are no complete human-computer interaction theories (Fischer, 1989), and stable and complete guidelines for interface design are felt to be several decades away (Shneiderman, 1987, p. 417), although a few key interface design principles have been identified and accepted (Gould & Lewis, 1985; Wilson & Rosenberg, 1988, p. 865). The LIW end-user searching interface described below, therefore, was developed from first
principles and in response to the specific considerations described above rather than according to any existing prescription. It continues to be refined and developed based on experience and observation.

A CUSTOMIZED IMPLEMENTATION EXAMPLE

As an illustrative example of the UIUC LIW as currently implemented, Figure 2 shows the opening LIW menu as defined for the UIUC Music Library installation of the system. Menu pick number 1, “Online Catalog,” provides access to the statewide online catalog (IO). At the Music Library, as at most sites on the UIUC campus, access to IO is provided via user-friendly microcomputer interface software developed by UIUC Prof. C.-C. Cheng (1985). Elsewhere in the state, most patron access to IO is via the more recently developed mainframe interface.

Menu pick number 2, “References to Articles in Journals & Magazines,” provides access to the statewide BRS/SEARCH implementation for searching bibliographic databases (IBIS). Note that the database availability indicated in Figure 2 is specific to UIUC. Exact database availability varies slightly on other campuses in the statewide ILSCO consortium. The LIW interface to IBIS is discussed in detail in a later section.

Menu pick number 4, “UIUCNet Services,” provides access to database and telecommunications resources on the UIUC campus fiber-optic network. In this particular installation, one may access the electronic version of the OED, the campus phone and e-mail address directory, and preselected OPACs from other institutions. Figure 3 shows a selection of UIUCNet resources specific to the Music Library implementation of the LIW.

Data files generated and maintained by each library (menu picks number 3 and 5) are stored on the microcomputer hard disk and searched using a locally developed, sequential search database management system integrated into the LIW. The search software, written in the Microsoft BASIC Professional Development System language, was authored by UIUC faculty members William Mischo, Timothy Cole, and David Stern. A primary goal of developing the search software in-house was to facilitate the interchange between IO+ applications.

This sequential search application is intended for ASCII files up to a few megabytes. Since data files are unindexed and standard ASCII in format, they can be created in a variety of ways. Data files can be created by downloading from sources such as IO or IBIS; files may also be created with standard word processors and saved as ASCII text. The
files can be customized for a very specific user population. Files created for the Music Library include the Journal List, Current Acquisitions List, Cumulative Acquisitions List, Compact Disc List, Video List, Dissertation List, and Resource Guide (see Figure 4). A help screen supplements the description given for each of these files in the IO+ menu “Explanation Box” (see upper right-hand corner of Figure 4).

In some cases, files are created to complement access to materials in the online catalog. For example, in IO it is not possible to limit one’s search to only CDs, yet many of the Music Library’s clientele request CDs specifically. For several years, a separate dBase III database was maintained. When that was no longer feasible, the sound recording portion of the electronically prepared monthly acquisition list was appended to a printout of the dBase III file. These files have now been combined and may be searched using this application. Because files are unindexed, they are updated easily; new material is simply appended.
Files are searched sequentially from beginning to end, byte by byte. The inherent power and speed of the IBM PS/2 machine—the IBM PS/2 Model 30 286 is the recommended minimum platform for LIW implementation—combined with recent improvements in Microsoft BASIC permits a file to be searched very quickly, even in this sequential search manner; file indexing is unnecessary. Since the files are not indexed, the user need not worry about searching specific fields or using controlled vocabulary. The string search algorithm used permits both right- and left-hand truncation.

For flexibility, the integrated LIW sequential search software does accommodate record delineation. By creating discrete records within the file, the use of Boolean logic becomes possible. A set of reversed brackets is used to delineate the end of a record. End-of-record markers may be introduced into a file by means of a word processing macro.
Beethoven, Ludwig van, 1770-1827.

VIDRECM1500B33F521985

VIDRECM1500B33F521985 BEETHOVEN, LUDWIG VAN, 1770-1827. FIDELIO NEW YORK
NOLC 320793 1985 1 ADDED: 870927 NENG
01 001 4W MUQ RCALL 921030/930104 UC
02 001 SAVE 921212 UC

Press ENTER to resume search, or type an LCS command.

Figure 5. Local file search results and their circulation status

In addition, files created by downloading from IO using another locally created library staff application, Illinois Search Aid, can be automatically supplied with reverse brackets between bibliographic records.

Available options include searching a single term, searching for two or more terms within one record (the logical operator "and"), and searching for any of two or more terms in a record (the logical "or").

Mentioned above was the goal of facilitating the interchange of information between applications. One example is a local data file that contains catalog call number information. The LIW software permits a dynamic link between local file search results and current IO circulation status and holding information (see Figure 5).

SEARCHING FOR JOURNAL ARTICLES ON THE LIW

Selection of the "References to Articles in Journals & Magazines" LIW main menu pick starts a microcomputer-mediated session on IBIS, the local implementation of the BRS/SEARCH information retrieval system. Figure 6 shows the opening IBIS interface menu screen for an ERIC database search. The three-windowed approach of the LIW main menu screens is preserved providing a sense of integration and continuity. In addition to this basic three-windowed menu approach,
the IBIS interface also uses pop-up dialog boxes and pop-up and bar menus. Wherever possible, the interface uses menus to solicit user inputs. Where dialog boxes are required, illustrations and detailed prompt texts are provided.

The extensive use of menus minimizes the need for IBIS users to know explicit command syntax or specific database features or nomenclature. Instead, menus tailored to each IBIS database are provided. Using the menu shown in Figure 6, even users unfamiliar with ERIC are immediately made aware of powerful ERIC search features such as educational level terms and age descriptor codes. The menu approach allows patrons to use these features without having to learn and memorize specific field or search codes. Similar special feature search menus are provided for other IBIS databases. Consistent across these search menus, selections are listed from broad (e.g., keyword searches;
title and descriptor searches) to narrow (e.g., corporate author searches; publication type searches).

The IBIS microcomputer interface uses an "expert systems approach," incorporating a great deal of experienced searcher expertise behind the scenes. All entered search terms and phrases are parsed and checked by the microcomputer interface software before being formulated into the proper syntax and sent off to the mainframe BRS/SEARCH implementation for processing. Appropriate operator and search field codes are added. Search phrases are checked for database-specific stop words, system-reserved words (e.g., Boolean operators; adjacency operators) that might lead to ambiguous results and obvious redundancy or incompatibilities with previously entered terms. The end-user is warned or asked to reenter the search argument according to the nature of the specific problem.

To further facilitate end-user searching, the microcomputer IBIS interface uses a search strategy formulation technique centered around the software creation and combination of user-entered search terms and concept groups. This approach is patterned after the "concept building block" approach to online searching, one of three classical techniques for performing effective searching (Pfaffenberger, 1990, pp. 106-107). The concept group approach was demonstrated by Marcus (1981) in an experimental system and has been adapted in several commercial systems, including the DIALOG CONNECTION systems (Large, 1990, pp. 30-32) and BRS/AFTER DARK (Guidelines, 1989), and several academic end-user systems (Pollitt, 1990; SearchMate, 1990). In addition to being a logical method for building and modifying search strategy, the concept building block approach also facilitates bibliographic instruction, both in group settings and one-to-one, and eliminates the need for user mastery of the various Boolean search operators.

Figure 7 shows the help screen that describes and illustrates this building block search approach as implemented in the LIW IBIS interface. This screen comes up automatically when the user begins his or her search. A more elaborate, extensive description of this search process can be requested by the patron from this summary help screen. Experience with this approach in various forms at UIUC has shown that it indeed helps address and reduce many of the end-user searching difficulties described above (Mischo & Moore, 1989).

Of course, not all cases can be covered in manageable menus, and there may be unanticipated occasions where parsing of a search string may not be desirable. To accommodate this case and to allow for a librarian to help a patron without having to exit the IO+ interface code, two forms of BRS native mode command "pass-thru" are allowed
by the microcomputer interface program. For a single search term or process that will result in the generation of a single search set, program parsing can be disabled. For more extensive native mode activities or to review what has been done so far in native mode, the interface can be "turned off" completely, allowing for a direct native mode session between the terminal and the mainframe.

Finally, allowance has been made in the software for some workstation-specific interface tuning. The IBIS microcomputer interface has the built-in capability to trap for search inputs specific to a particular subject or library clientele and make automatic substitutions before forwarding the search argument to the mainframe BRS/SEARCH implementation (the user is notified on the search term entry screen). Trap/substitution lists used by the interface in performing this function can be both database and workstation specific. (An example of this substitution operation is described below.) Additionally, available interface output options can take advantage of specific, local workstation
printing and downloading capabilities. Lastly, the help screens that describe and illustrate the search process can be modified easily for a specific workstation or cluster of workstations.

Figures 8-14 show a sample microcomputer-mediated IBIS search for information about interfaces to online catalogs done in the ERIC database. In addition to performing a keyword search, the hypothetical searcher is also aware of an author writing in the subject area and so wants to add in any works by that author whether picked up in the keyword search or not. Finally, having a fairly large retrieval set, the searcher decides to limit the final search set to conference paper or speech citations.

Figure 8 shows an initial keyword concept term entry dialog box. Note the illustration included in the prompting for term entry. After a user has searched for the first term of a concept, he is given the opportunity to add additional related terms to the concept. Choosing
to do so will bring up the slightly modified search term entry box shown in Figure 9. The user is reminded of the first search term in the concept in the prompt for all later related terms in a concept.

After the user has entered all the terms in a given concept, he is asked if he wants to narrow his search with an additional concept (i.e., do a Boolean AND search), broaden his search with an additional concept (i.e., do a Boolean OR search), or take one of several other actions (see Figure 10). In this example, the user chooses to narrow with an additional keyword search term. (Different types of searches can be combined within the concept building block approach, as illustrated by concepts 3 and 4 described below.) Figure 11 is the dialog entry box for entering the first term of concept 2. Note the automatic substitution for the patron's entry of "interface" as a search term. As mentioned above, this substitution was made using a list of terms particular to the workstation on which the search is being done.

SEARCHING: Complete ERIC LAST UPDATE: 12/01/92

Current Concept 1: online catalogs;
Last Term Entered: online catalogs
RESULT: 958

Entering SYNONYMS or RELATED TERMS for CONCEPT 1 terms.
Other topic ideas should be put in separate Concepts.

Enter ONE TERM (Word or Phrase) AT A TIME (+ ENTER Key)
F3 to FINISH this CONCEPT, combine results, GO to NEXT CONCEPT
F4 to Print or Display Results

Another Alternate term for online catalogs:
opacs

..SEARCHING

Figure 9. Modified search term entry box
After adding a second concept, our hypothetical patron next decides to broaden his search by adding in all citations attributed to a particular author. Figure 12 shows an author entry dialog box with entry template. This template removes any ambiguity about order or form of personal name entry. The template is consistent across databases; database-specific syntax and field nomenclature are taken care of behind the scenes by the interface software.

Finally, the patron uses the main IBIS microcomputer interface search menu to narrow his search set to "Speeches, Conference Papers." In response to the menu selection, the interface generates and sends the appropriate publication type search command and displays an already filled in search term dialog box to the user (Figure 13). The resulting retrieval set is 11 documents. An interface-generated summary of the entire search is shown in Figure 14. Contrast this with the summary generated by the BRS/SEARCH native-mode "..d all" command shown...
Figure 11. Dialog entry box for entering the first term of concept 2

in Figure 15. Note the work done behind the scenes by the interface software.

Appropriate adjacency and Boolean operators have been inserted by the interface. The automatic substitution of "(INTERFACE$1 OR FRONT ADJ END$1 OR GATEWAY$1)" for the original user input of "interface" has been made (search set 4). The author name has been hyphenated, a preferred form constructed to improve recall, and the name has been searched in both the author field and the abstract field (which in ERIC is usually the only place where authors of individual conference papers are indexed). Finally, the appropriate ERIC-specific publication type code for "Speeches, Conference Papers" has been sent by the program in response to the patron's menu selection. As much as feasible, the burden for knowing proper syntax and database-specific index practices has been shifted from the end-user to the interface software.
Having facilitated the patron's search, the interface also simplifies the display/output of search results. Again the intent is to have the user make his or her output selections from a menu and have the interface software interpret those selections and generate an appropriate BRS/SEARCH native mode command. Figure 16 shows the output options available to patrons using the IBIS microcomputer interface including e-mail and downloading of citations to diskette. After selecting the output mode, the user then selects the desired output format as shown in Figure 17. A typical citation printout (from an IBIS search of ISI's Current Contents database) is shown in Figure 18.

Note the full-paragraph labelling and the formatting of the citation printout. This is done on the mainframe by the BRS/SEARCH printtime formatting process. The added line at the end of the citation showing UIUC library call number and three-letter library location
code is added by the microcomputer interface software. The interface recognizes the citation source field as it displays or prints the citation and then performs a search of a local database file stored on the workstation hard disk to find the call number of the item (using the same algorithm developed for local database searching and described previously). The fact that this look-up file resides on the workstation easily accommodates the campus-to-campus variations in information about journal availability, call numbers, and location information.

**CONCLUSION: FUTURE DEVELOPMENTS**

The software functions of the Library Information Workstation have evolved over the course of the project as the various IO+ resources
<table>
<thead>
<tr>
<th>SET NUMBER</th>
<th>SEARCH TERM</th>
<th>RESULT</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>online catalogs (Keyword)</td>
<td>958</td>
</tr>
<tr>
<td>02</td>
<td>opacs (Keyword)</td>
<td>81</td>
</tr>
<tr>
<td>03 CONCEPT 1</td>
<td>online catalogs; opacs;</td>
<td>959</td>
</tr>
<tr>
<td>04 CONCEPT 2</td>
<td>interface;</td>
<td>2344</td>
</tr>
<tr>
<td>05</td>
<td>CONCEPT 1 AND CONCEPT 2</td>
<td>99</td>
</tr>
<tr>
<td>06 AUTHOR 1</td>
<td>mischo, william h</td>
<td>5</td>
</tr>
<tr>
<td>07</td>
<td>(CONCEPT 1 AND CONCEPT 2) OR AUTH 1</td>
<td>103</td>
</tr>
<tr>
<td>08 CONCEPT 3</td>
<td>Speeches, Conference Papers</td>
<td>68969</td>
</tr>
<tr>
<td>09</td>
<td>((CONCEPT 1 AND CONCEPT 2) OR AUTH 1) AND CONCEPT</td>
<td>11</td>
</tr>
</tbody>
</table>

**Figure 14. Interface-generated search summary**

have become available. IO+ and the UIUC campuswide information system will continue to expand and add new resources, and the UIUC LIW will add new features and continue to refine its present functionality in response.

Specific work is underway to expand the UIUC LIW to provide enhanced access to a number of new information resources including many outside the UIUC library system itself. In December 1993, the UIUC will open the new Grainger Engineering Library Information Center. The Grainger Center will feature state-of-the-art computing and networking facilities. All LIWs within the center will be able to access campus and Internet network resources. Additionally, several high-capacity, in-house network servers will provide a number of supplemental information access resources and capabilities.

In-house services currently under design and development for the new Grainger Center include networked CD-ROM databases; a
ERIC LAST UPDATE: 12/01/92
1 ONLINE WITH CATALOGS
   RESULT 958
2 OPACS
   RESULT 81
3 1 OR 2
   RESULT 959
4 (INTERFACE$1 OR FRONT ADJ END$1 OR GATEWAY$1)
   RESULT 2344
5 3 AND 4
   RESULT 99
6 MISCHO-WILLIAM$-H$.AU. OR MISCHO-W-H$_.AU. OR WILLIAM ADJ H ADJ MISCHO OR
   WILLIAM ADJ MISCHO
   RESULT 5
7 5 OR 6
   RESULT 103
8 150.PT.
   RESULT 68969
9 7 AND 8
   RESULT 11

**** END OF DISPLAY ****

BRS SEARCH MODE - ENTER QUERY

Figure 15. BRS/SEARCH search summary

((CONCEPT 1 AND CONCEPT 2) OR AUTH 1) 11 Refs

SELECT DISPLAY/PRINT/E-MAIL OPTION (+ ENTER)

Display References on Screen
DOWNLOAD References to 3.5 in. Diskettes
Print to High-Speed Printer (NOT YET AVAILABLE)
Send Result to Electronic Mailbox
Print on Attached Printer
EXIT THIS MENU

Figure 16. Output options using the IBIS interface
Grainger Center BRS/SEARCH implementation to support access to databases of interest to Grainger patrons but not of sufficient interest to justify loading on the statewide BRS/SEARCH implementation IBIS; Internet access to online catalogs at other CIC schools; access from all workstations to campus network resources such as the OED, local area weather forecasts and alerts, and campus phone/e-mail directory; state-of-the-art scanning, computer-aided-design, and computer-aided-instruction hardware and software; and coordinated full-text article retrieval and delivery via fax or image transmissions over network connections. Figure 19 provides a preliminary indication of the kind of services that will be available from the Grainger Center LIWs.

The LIW interfaces as well will evolve to incorporate enhanced search techniques such as Best Match and Partial Match algorithms, term query expansion, and knowledge-based query expansion. We are interested in exploring the "find another like this one" approach to
Research conducted in the early 80's has shown that subject access is still one of the most dominant approaches in OPACs. However, while some of the subject searches result in no recall, others often retrieve so much

expanding search results. Interfaces will increasingly make use of state-of-the-art multimedia and graphical techniques to accommodate and facilitate more effective user information-seeking behaviors.

The UIUC Library IO+ extended OPAC and campuswide information services provide users with access to a myriad of local and remote information resources. The Library is committed to making these resources available and facilitating their use through the continued evolution of the Library Information Workstation.
**ILLINET ONLINE PLUS (10+)**

Select Database to be Searched

<table>
<thead>
<tr>
<th>MAIN MENU SEARCH OPTIONS:</th>
</tr>
</thead>
<tbody>
<tr>
<td>USE ARROW KEYS/ Mouse TO</td>
</tr>
<tr>
<td>SELECT, then Press ENTER</td>
</tr>
</tbody>
</table>

- Online Catalog
- References to Articles in Journals & Magazines
- Information & Help files
- Communications
- Materials Processing
- Word Processors
- Exit Options

**EXPLANATION:** Communications

Connect to Building LAN, UIUCNet, or Internet network resources, or open a modem connection.

**CHOICES:**

- Oxford English Dictionary
- Campus Telephone Directory
- Weather Information
- Gopher Information Systems
- Other Library Catalogs
- Dasher Connection
- TCP/IP Connection
- Modem Connection

**EXIT THIS MENU**

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Figure 19. Future services available from the Grainger Center LIWs

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### REFERENCES


