Extending the Access and Reference Service Capabilities of the Online Public Access Catalog

In a 1985 review of online catalog research and development activities spanning the years 1980-85, this author pointed out that two different questions were frequently posed in the literature on online catalogs: "Are these new systems really library catalogs?" and "Are they really online information retrieval systems" (Hildreth, 1985, p. 239)? In other words, do the early online catalogs match up to some set of fundamental criteria which define: (1) a genuine library catalog, or (2) an information retrieval system?

The online catalogs available in the early 1980s faced critical scrutiny from two different, unaligned segments of the library and information science community. Many traditional library catalog apologists looked upon the new online catalog as a dangerous impostor: friendly and popular but lacking the synhetic structure and functional properties (e.g., collocating and browsing features) required of a true catalog. On the other hand, online information retrieval specialists responded to the online catalog as if it were a new stepchild whose standing in the family was suspect at best. Actually, the new family member was little noticed and little respected by the information retrieval experts.

Proceeding along different paths, the developmental histories of online public access catalogs (OPACs) and conventional online information (or reference) retrieval (IR) systems differed in three respects: origins of system development, file and database content, and intended users. Early online information retrieval systems were developed into operational systems by government agencies or commercial firms for use in database searching by trained professionals who came to be known as "search inter-
mediaries.” In the late 1970s, many libraries began major planning and development efforts to provide online public access to their catalogs. Several university libraries began their own development of patron access retrieval systems, and many other libraries encouraged the vendors of their turnkey automated circulation control systems to begin development of public access catalogs. Librarians and library system designers—not the search service vendors—were the first to focus on patron access to online library files. The files then available for direct patron access contained either shortened catalog records supplemented by item location and status data stored in the automated circulation systems or MARC (machine-readable cataloging) records acquired from one of the shared cataloging utilities such as OCLC or RLG/RLIN. Stand-alone, online library catalog systems were built by several universities largely to provide direct patron access to the library’s MARC database.

One of my aims in the 1985 review article was to begin to bridge the wide gulf between the advances of information retrieval theory, research, and practice and the world of OPAC research, design, development, and use. Prior to 1985 there had been divergence and little crossover between these camps. Earlier forms of the library catalog were of no interest to IR specialists and researchers, and the new online form was viewed as little more than a mechanized card catalog. On the other hand, online catalog designers sensitive to the needs of untrained end users were reluctant to adopt the prevailing model of conventional, commercial online reference retrieval systems used almost solely by trained search intermediaries.

A close look at developments and opportunities as they existed in late 1985 led to the belief that we were at the threshold of a creative convergence of two separate movements. The advances in understanding the problems and needs of end user searching of IR systems seemed transferable to OPAC use, and some online catalogs, as they evolved, were beginning to incorporate the more sophisticated keyword and Boolean search methods common in the conventional IR systems. The transformation of the library catalog into a diverse, online information resource had begun. The promise was clear: OPACs could be better library catalogs than their predecessors, and OPACs could be both powerful and usable interactive retrieval systems.

Today, we must recognize that much of this promise is being fulfilled. Existing second-generation OPACs with their MARC catalog record databases can be viewed from a functional perspective as special purpose online reference retrieval systems. Some of them even satisfy Cutter’s (1904) classic objectives for the library catalog:

1. to enable a person to find a book of which either the author, or the title, or the subject is known;
2. to show what the library has by a given author, or on a given subject, or in a given kind of literature;
Theoretical discussions of the proper content, structure, form, and function of the library catalog typically salute Cutter’s objectives, thereby recognizing these objectives as foundational, first principles of the library catalog. While it is true that most twentieth-century library catalogs which incorporate Cutter’s principles are largely monograph-oriented and provide no access to the periodical literature, Cutter’s requirements, when fully understood, are a good place to start in achieving a good library catalog. However, if we are to provide the kind of access tool Quint (1987) describes as a “full-collection library catalog,” we must advance beyond the Cutter catalog (p. 90). This can be accomplished without diluting or sacrificing Cutter’s principles. Unfortunately, early OPACs came up far short of Cutter’s ideal. These first-generation OPACs could be fast “known-item” look-up mechanisms when presented with precise author, title, or control number information, but they lacked the syndetic structure, linking references, and logical file organization necessary to function as a Cutter catalog.

In any area of science there is always some distance between theory and practice, some gap between institutionalized ideals (the conventional wisdom?) and actual accomplishments. In the past the available technologies of the library catalog accounted for the lag between actual library catalogs and the science and theory of the library catalog. Book, card, and microform catalog media were constraining technologies. Each had its inherent limitations, well known to every library science student who has had to learn the litany of the advantages and disadvantages of each “form” of the catalog. Ironically, the very existence of these early technology-based physical limitations has too often had a constraining influence on theory. More specifically, the old forms of the library catalog have limited how we dare to think about the potential of the library catalog as it may exist in an unconstrained physical environment. As we have passed irreversibly into the online access era with its wide availability of machine-readable bibliographic records for most items in any library’s collection, we are witnessing something of a scientific revolution in our arena. Library catalogs in operation no longer have to fall short of the ideal because of the dead weight (maintenance) and costs associated with outmoded catalog technologies. In fact, the practice of developing, introducing, and extending the resources and capabilities of the online library catalog in our libraries and library consortia is outpacing academic speculation and theoretical discussions about what constitutes the “proper” library catalog. The technology of the online public access catalog has unleashed imaginations and has created an avalanche of possibilities for improving library catalog-based
services. With a quickening pace, librarians are exploiting these possibilities to provide both deeper and more comprehensive access to the information and materials in their collections.

It is no longer fashionable to view the online catalog as merely a new form of the traditional library catalog, that is, as a sort of mechanized card catalog. Such a view represents a backward, unimaginative perspective. The best of today’s online catalogs have transcended the limitations of the earlier forms of the library catalog (i.e., book, card, and microform). The unique characteristics of the online catalog account for this quantum leap forward: it is an interactive medium, it is infinitely expandable in function and content, and it is a public, self-revealing, self-tracking access instrument.

All of this makes it very difficult to define the ideal library catalog in the traditional manner, an approach which poses a theoretical construct imbued with the appropriate principles: the result being an ideal which actual catalogs should measure up to and could if only the costs were not prohibitive.

Accordingly, this discussion will not attempt a definition of the “extended OPAC.” It will be pointed out that “extended” means, among other things, to enlarge the scope of, to make more comprehensive or inclusive, and to cause to move at a full gallop.

Today, library catalog analysts more commonly write about the potential of the online catalog or discuss its impact on library organizations and services. Malinconico (1984) has written:

There is little doubt that we are standing on the threshold of changes that will alter the catalog and library service in ways that we can only dimly perceive. The library catalog will very likely change into something that bears little resemblance to the instrument we currently know. (p. 1213)

Recognizing the futility of defining the ever changing online library catalog, Hildreth (1985) suggests that even the name “online catalog” will soon be an inaccurate and outdated label for this new access phenomenon.

It is time to start thinking of the online catalog as an intelligent gateway to diverse, integrated information resources for both the information specialist and the library patron or end user; a gateway accessible not only in libraries, but at places of work, study, leisure and the home. Perhaps someday the online catalog will just be called “my online library.” (p. 246)

The remainder of this article will be devoted to: (1) a discussion of the present state of operational OPACs and highlight some recent developments, (2) an outline of certain problems and shortcomings of current OPACs, problems that illuminate the need for improvements and extensions, and (3) suggesting eight different ways today’s OPACs can be extended to improve their access and service potential to library users.
SECOND-GENERATION ONLINE CATALOG

A few years ago, this author classified three generations of online catalog developments to chart recent history and to cast some light on the likely course of future catalog design (1984). This approach assumed we could identify qualitative stages of evolution in the design and production of online catalogs. Each of the three generations was defined by a characteristic set of features (see Figure 1).

The three-generation classification of online catalogs is useful once again, because it provides a framework for explaining precisely where online catalog development stands today. Almost without exception, we have moved beyond first-generation online catalogs. That is the good news. However, online catalog development has slowed to a snail’s pace. Many of the commercial suppliers of second-generation online catalogs believe they have “finished” the job by adding online public access catalogs to their product lines. The danger exists that these commercial suppliers of online catalog systems will become stuck on the plateau of second-generation developments.

This period of developmental slowdown or complacency on the part of the commercial suppliers of online catalogs has its positive side. For librarians who will be involved in the evaluation and selection of online catalogs in the future, it provides time for learning and “catching up” on the state of the art, online access issues, and users’ needs. It is necessary to understand how today’s online catalogs have moved beyond the first-generation systems. First-generation online public access catalogs were characterized as being “known item” finding tools which provided few access points (typically only author, title, and control number) to short, nonstandard bibliographic records. They were either crude attempts to replicate the card catalog online or automated circulation database query systems masquerading as public access library catalogs. Many agree with Malinconico’s (1983) astute analysis of circulation control systems as falling far short of any system deserving to be called a library catalog.

In first-generation catalogs, searching was initiated by derived-key input or by exact term or phrase matching on at least the first part of the term or phrase (as with heading searches in the card catalog). In addition to lacking subject access, including any keyword access to titles and subject headings, first-generation online catalogs provided only a single display format, a single mode of interaction with the system, and little or nothing in the way of online user assistance. Refining and improving a search in progress, based on an evaluation of intermediate results, was out of the question. Without subject access, authority-based searching with cross references, and meaningful browsing facilities, first-generation online catalogs were understandably criticized as inferior to traditional library catalogs.
<table>
<thead>
<tr>
<th>ACCESS DIMENSIONS</th>
<th>FINDING TOOLS</th>
<th>INFORMATION RETRIEVAL SYSTEMS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. SEARCH/ACCESS</td>
<td>Controlled vocabulary subject access via assigned headings.</td>
<td>2nd Generation Enhancements</td>
</tr>
<tr>
<td>2. KNOWLEDGE BASES</td>
<td>Exact phrase or derived-term search paths.</td>
<td>Full authority-based/guided access.</td>
</tr>
<tr>
<td>4. DISPLAY FORMAT/CONTENT</td>
<td>Single dialogue mode for all users; either command language or menu selection.</td>
<td>Single display format.</td>
</tr>
<tr>
<td>5. INTERACTION/DIALOGUE MODES</td>
<td>Two or more selectable dialogue modes (novice, expert, etc.).</td>
<td>Multiple display formats.</td>
</tr>
<tr>
<td>6. OPERATIONAL ASSISTANCE</td>
<td>Extending access and reference</td>
<td>Expanded access via (1) integration of free text and controlled vocabulary search approaches, (2) augmented search strategy aids, and (3) enhanced bibliography enrichment.</td>
</tr>
</tbody>
</table>

Figure 1. Online catalog progress across generations
Today's second-generation online catalogs represent a marriage of the library catalog and conventional online information retrieval systems familiar to librarians who search online abstracting and indexing databases via DIALOG, BRS, DATASTAR, MEDLINE, etc. Improved card catalog-like searching and browsing (via headings and cross references) capabilities have been joined with the conventional IR keyword and Boolean searching approaches. Many online catalogs support the ability to restrict searches to specified record fields, to perform character masking and/or righthand truncation, and to limit the results by date, language, place of publication, etc. Also, bibliographic records may be viewed and printed in a number of different display formats.

Second-generation online catalogs should be viewed as bibliographic information retrieval systems. But when compared to their conventional IR forebears, these key differences should be kept in mind:

—the online public access catalog must be usable directly by untrained and inexperienced users (online assistance is usually provided to help with the mechanics of searching);
—records in the catalog database lack abstracts, the subject indexing is sparse and uses broad terms not representative of current terminology; and
—the catalog database, in covering a library's collection, includes information on a wide variety of disciplines and subject areas.

Designers of second-generation online catalogs have addressed these differences in two ways: by providing card catalog-like precoordinated phrase searching and browsing options (along with keyword/Boolean capabilities), and by providing more and more online user assistance in the form of menus, help displays, suggestive prompts, and informative error messages. On the other hand, postcoordinated keyword searching on subject-rich fields (e.g., titles, corporate names, series entries, notes, and subject headings) serves to alleviate the twin problems associated with the sparse subject indexing of most library materials by the Library of Congress (using its list of subject headings—"LCSH") and the users' unfamiliarity with the controlled indexing vocabulary.

A library catalog that fulfills Cutter's classic objectives for the catalog in the online environment is a significant accomplishment. It succeeds in at least two ways: users prefer the online catalog to either the card or the COM catalog, and the online catalog is easier to maintain and update than earlier forms. Designing a keyword/Boolean information retrieval system as an online catalog that is easier to learn and easier to use than the conventional, commercial IR systems is also a significant accomplishment. The traditional, well-structured library catalog has been joined with the power and flexibility of conventional IR systems. The prevailing
The Need for Further Improvements

Experience tells us that second-generation online catalogs can be used effectively by library staff and by library patrons trained to use and understand their particular indexing and search idiosyncrasies. Most of these online catalogs are not yet effective, usable "self-service" information retrieval systems for a wide variety of untrained, occasional users.

The potential of the online catalog to provide improved access to library materials and the information they contain is still largely untapped. Eventually, the forces of innovation and market competitiveness will boost online catalog development off the second-generation plateau. However, we should not expect a giant, discontinuous leap forward to the next generation of online catalogs. Rather, progress is likely to be made in small, incremental steps. Some of the new developments will almost certainly be technology driven. Combinations of new hardware, especially more intelligent workstations, and software techniques will be applied to new and improved library catalogs and retrieval systems. We will see more "WIMPs" (Windows, Icons, Menus, and Pointers) at the user interface. Already, the CD-ROM-based online catalog is being touted as yet another new form of the catalog. The danger is that future design and development efforts will neither be "user driven," nor incorporate the knowledge learned from information retrieval research and experimentation to improve conventional Boolean retrieval systems (Mitev & Walker, 1985; Harper, 1980; Oddy, 1977; Hendry et al., 1986).

Online catalog research studies have uncovered a number of common problems experienced by users of second-generation online catalogs. Solutions to these problems should constitute the design agenda for improved online catalogs. In general terms, the major problems include:

—too many failed searches (search attempts that are aborted, that result in no matches, or that result in unmanageably large numbers of items retrieved) (Markey, 1986; Markey, 1984);
—navigational confusion and frustration for the user during the search process ("Where am I?" "What can I do now?" "How can I start over?") (Knipe, in press);
—unfamiliarity with or ignorance of the subject indexing vocabulary leading to the failure to match search terms with the system’s subject vocabulary (Markey, 1986);
—misunderstanding and confusion about the fundamentally different approaches to retrieval and search methods employed in today's online
catalogs (e.g., precoordinate phrase searching and browsing, and postcoordinate keyword/Boolean searching) (Kranich et al., 1986); and
—partially implemented search strategies and missed opportunities to retrieve relevant materials (e.g., searches in which large retrieval sets are not scanned or narrowed in size, and title keyword searches that are not followed by searches on the call numbers or subject headings of the found records).

Chan (1986) points out that online searching is a process of extracting a subfile of useful documents from a large file, a process where “in most cases, a sequence of search statements is required for even minimally satisfactory retrieval” (p. 191). To optimize retrieval results in subject searching, more than one search approach may have to be employed in the overall search strategy: “Through combination, keywords and the [controlled] vocabularies, of DDC, LCC, and LCSH should offer far greater possibilities in search strategies than any one of them can provide alone” (Chan, 1986, p. 188. See also Croft, 1981). Markey (1986) has demonstrated, for example, that different records on a particular subject would be retrieved by using a classified approach from those retrieved using keyword or alphabetical subject heading browsing approaches.

Conventional IR systems place the burden on the user to reformulate and reenter searches until satisfactory results are obtained. This is typically the case with second-generation online catalogs as well. This approach assumes, however, that the user knows what he wants and can describe it in the language of the catalog database being searched.

Hjerppe (1986) quite correctly rephrases this problem as the fundamental paradox of information retrieval: “the need to describe that which you do not know in order to find it” (p. 14). Even the best second-generation catalogs do little to help the user transform an information need to explicit descriptions of the information understandable by the system. Nor do these catalogs lead the user from “found” information to related, linked information that has not yet been discovered. It is unrealistic to expect catalog users to know in advance the structure and language of library databases. It is equally unrealistic to expect online catalog users to be proficient in the various search approaches and techniques before they engage an interactive system in the retrieval process. Hjerppe (1986) reminds us that humans are much more adept at recognizing something than generating a description of it. Online catalogs could take advantage of this human facility by permitting requests such as, “Give me more like this!”

In summary, second-generation online catalogs fall short in that they:
—do not facilitate open-ended, exploratory searching by following pre-
established trails and linkages between records in the database in order to retrieve materials related to those already found;
—do not automatically assist the user with alternative formulations of the search statement or execute alternative search methods when the initial approach fails;
—do not lead the searcher from successful free-text search terms (e.g., title words) to the corresponding subject headings or class numbers assigned to a broader range of related materials;
—do not provide sufficient information in the retrieved bibliographic records (such as tables of contents, abstracts, and book reviews) to enable the user to judge the usefulness of the documents;
—do not rank the citations in large retrieval sets in decreasing order of probable relevance or "closeness" to the user's search criteria.

WAYS OF EXTENDING THE OPAC

Figure 2 lists eight ways the conventional library catalog is being extended in a variety of online manifestations in libraries. Most of these extensions involve adding data to the MARC catalog records, integrating related data files such as customized periodical indexes into the monograph catalog, or adding reference information files to the overall OPAC database or aggregate of databases searchable through the OPAC. However, functional and transactional performance extensions are also being made to today's second-generation OPACs. This is all to the good because research and experience have provided sufficient reason not to be satisfied with the performance of today's OPACs. Reflecting on all this creative, expansive activity to OPAC designers and librarians, it is clear that in practice no pre-defined "theoretical" boundaries for the proper library catalog (regarding its form, function, or content) are being respected or observed. We are witnessing a shift in emphasis from usual concerns for bibliographic control to expanding access to all the materials and information in the collections. The promise is that the library's primary access instrument, the "catalog," will become its most used and most effective access and discovery tool.

FUNCTIONAL SEARCH AND RETRIEVAL ENHANCEMENTS

This author has written elsewhere about the opportunities for extending the OPAC's service potential through augmented MARC records and the integration of periodical indexes into the catalog database (Hildreth, 1987). Several OPACs are also extending access to local reference information files and, through gateways, to remote online database search services.
1. Functional Search and Retrieval Enhancements

2. MARC-PLUS Augmented Catalog Records (subject descriptors, headings from tables of contents, classification vocabulary)

3. Integration of Local Non-MARC and Pseudo-MARC Bibliographic Records (non-standard records and subject pathfinders, abstracts, book reviews, and research guides)

4. Advanced Database Syndetic Structure (defining customized sub-catalogs and subject-based trails and pathways)

5. Additional Self-Service Convenience Functions (self-charging, online ILL or reference service requests)

6. Created and Maintained Information Files

7. Remotely Published, Locally Stored and Accessed Information Files

8. Gateway Access to External Bibliographic and Information Files (online reference databases, other OPACs, and electronic union catalogs)

Figure 2. The extended OPAC

This article concentrates on the first extension listed in Figure 2: search and retrieval enhancements or how to create a smarter OPAC.

Improving second-generation online catalogs is a twofold challenge: (1) making them more effective retrieval systems, and (2) ensuring that they are usable and satisfying to a heterogeneous population of end users—some trained but many untrained; some knowledgeable in one or more disciplines but many at the initial learning stages in a discipline.

Much advanced (post-Boolean) information retrieval research and theoretical analysis has been directed to improving the search performance and retrieval effectiveness of IR systems in controlled, experimental environments. While the research has focused on system performance factors, actual human searchers have been excluded from most IR experiments. Information retrieval researchers and theorists generally have been critics of Boolean logic-based IR systems and have experimented with a variety of alternative approaches that either attempt to ameliorate the shortcomings of classic Boolean methods (e.g., "extended Boolean" processing and "fuzzy-set" retrieval) or offer radically different, non-Boolean retrieval operations (e.g., query and document term vector processing and statistical, probabilistic retrieval methods) (Bookstein, 1985). A consensus seems to exist among information retrieval theorists and investigators regarding the shortcomings of IR systems that rely solely on Boolean logic query expression and processing. Salton (1984) presents the following list of reasons why conventional Boolean retrieval methodology is not well adapted to the information retrieval task:

1. The formulation of good Boolean queries is an art rather than a science; most
untrained users are unable to generate effective query statements without assistance from trained searchers.

2. The standard Boolean retrieval methodology does not provide any direct control over the size of the output; some query statements may provide no output at all, whereas other statements provide an unmanageably large number of retrieved items.

3. The Boolean methodology does not provide a ranking of the retrieved items in any order of presumed usefulness, thus all retrieved items are presumed to be equally good, or equally poor, for the user.

4. The Boolean system does not provide for the assignment of weights to the terms attached to documents or queries; thus each assigned term is assumed to be as important as each other assigned term, the only distinction actually made is between terms that are assigned (with an implied weight equal to 1), and terms that are not assigned (with an implied weight equal to 0).

5. The standard retrieval methodology may produce results which appear to be counter-intuitive:
   a. in response to an or-query (A or B or ... or Z) a record or document with only one query term is assumed to be as important as a document containing all query terms;
   b. in response to an and-query (A and B and ... and Z) a document containing all but one of the query terms is considered as useless as a document with no query term at all. (p. 277)

Online catalog research and design has been directed to making post-coordinate Boolean library retrieval systems easier to learn and easier to use than the commercial models used by trained intermediaries. Little attention has been given to the performance limitations of Boolean OPACs, and no university-developed or commercially available OPAC uses any of the advanced post-Boolean retrieval methods which have been tested with some success in the retrieval labs by the probabilistic and fuzzy-set retrieval theorists.

The shortcomings of second-generation OPACs and Boolean retrieval systems are now well known. There is no doubt that a vigorous dialogue between information retrieval researchers and online catalog designers could lead to improvements in online catalogs and other IR systems intended primarily for use by the "everyman" end user rather than trained search specialists. Much is to be gained by a sharing of their separate insights and theoretical or design advances.

OUTLINE OF APPROACHES TO INTELLIGENT INFORMATION RETRIEVAL SYSTEMS AND OPACs

The fundamental problem of information retrieval (by now it should be clear that OPACs are being viewed here as IR systems and not just mechanized card catalogs) is achieving a degree of precision in a situation that is inherently variable and imprecise. The situation is commonly expressed using the terms matching and retrieval. The implicit metaphor is visually entertaining if you do not picture yourself as the fisherman at a
poorly-stocked pond, using primitive reeling equipment. Something over there must be hooked and brought over here for display and evaluation. The "hook" in IR operations is some kind of matching mechanism. Of course the hook must have some suitable bait that will appeal to the kind of underwater specimen which is the object of the retrieval activity. A fair amount of knowledge and skill is required if one is to become a good fisherman.

In the IR/OPAC searching paradigm, the bait consists of query terms which attempt to express the searcher's information need(s), the document representations (citations, surrogates, catalog records, etc.) are the fish, and in automated systems the matching and retrieval software can be viewed as the rod and reel. At first glance the problem seems simple: match the user's query with the appropriate (relevant) document surrogates and retrieve them for the user's perusal and use. However, no matter the "type" of search query posed by the user (known item, topical), IR research has shown that the situation is loaded with variability and as a result uncertainty must be accepted as intrinsic to the retrieval process. From document description and subject analysis of texts to IR system design, efforts must confront the inherently probabilistic nature of the entire retrieval environment. The problem is complex and has many dimensions. No single "solution" is waiting to be discovered even with the coming of the "intelligent" interface. OPAC and IR research and development reflect this complexity and have taken a number of directions that may improve information retrieval in the automated environment.

So the problem is how to use the science and technology of automation to achieve the "best" retrieval for a given user query in an inherently imprecise and uncertain situation. Leaving aside the variabilities and complexities of subject cataloging/indexing, file structure, and matching and retrieval algorithms, the user may not know or be able to adequately express his need, or may simply change his mind during the retrieval process about what he wants or is interested in. In addressing the topic, "What is intelligent information retrieval?" Croft (1987) acknowledges the many advances made in the field of information retrieval since the arrival of the computer, but several basic issues remain unresolved. "To put it simply, we do not know the best way of representing the content of text documents and the user's information needs so that they can be compared and the relevant documents retrieved. We cannot even agree on a definition of relevance" (p. 249). Croft points to the small but significant improvements to the retrieval process where statistical approaches to the analysis of text and collections of documents have been applied.

Previous IR research has demonstrated that systems built on a probabilistic model outperform conventional inverted file, keyword/Boolean query-retrieval systems. Typically this approach exploits interpretations
of queries and document records based on weighted terms and extended or "loosened" Boolean logic. Some rudimentary natural language processing, either of the user's terms or terms used in the document representations (especially subject descriptors), is usually applied in the "matching" operation. But progress has been modest and has come slowly. As Doszkocs (1986) points out: "Investigators have been confronted with the variability of ways in which the same ideas and topics can be expressed by different authors, abstractors, indexers, and searchers, the inevitable limitations of the query-matching procedures and the contextual subjectivity of users' relevance judgements concerning retrieved items" (p. 192). Doszkocs characterizes the common goal of most IR researchers: "to transcend the limitations of the basic keyword/subject heading/inverted file/Boolean logic search paradigm characteristic of the mechanized systems of the 1960's and 1970's" (p. 192). In the process, IR researchers have come to recognize the inherently uncertain and probabilistic nature of the information retrieval process.

Understandably, IR and OPAC researchers find it lamentable that most OPACs in operation have "advanced" only to become conventional IR systems mixing Boolean query features and word proximity search capabilities. Beneath a more palatable user interface, today's OPAC closely resembles the retrieval methods of the conventional systems like BRS, DIALOG, and ELHILL (Medline's software). Fortunately, many IR researchers have taken an interest in OPACs and related "end user" systems, seeing them as fertile ground for further experimentation and development. Their activities are moving librarians piecemeal but solidly into the next generation of OPACs and IR systems. These efforts can be grouped into three or four different but complementary approaches to making these systems more "intelligent" and usable. My point of departure must be kept in mind: intelligent IR/OPAC systems begin where conventional systems end with regard to functionality, usability, and performance. The case against the conventional Boolean retrieval systems will not be made here. It is well documented in the literature. Also, it must be pointed out that some researchers and writers have a more restricted and more specific view of intelligent systems. In addressing what makes a system intelligent, they may require that the system have a knowledge base and rule-governed inferential capabilities that can be used to make the appropriate connections between a request (typically in natural language) and a collection of documents. If the knowledge base, rules, and logic are based on the knowledge and decision-making capabilities of real experts, the system is called an "expert" system. Building expert OPAC systems is one approach to making OPACs more intelligent; like the other approaches to be described, it has exciting potential as well as inherent limitations.
Researchers have shown that the challenge of retrieving documents that will have the highest probability of being relevant to the user's information needs and/or interests is not one dimensional. Add to these the challenge of making the system accessible for direct use by a variety of patrons, both trained and untrained, experienced and inexperienced. Clearly this is the situation facing librarians with improving subject retrieval in OPACs. It is not surprising that several approaches and different techniques are being applied to making OPAC and IR systems more intelligent. The emerging consensus is that progress lies in the direction of a combination of these approaches, employing features of the probabilistic model, dynamic interaction with the user during the search process to gather evidence about relevance and preferences, plausible inference methods (including natural language processing), and vastly improved presentations of data and assistance at the user interface.

What is being done to improve subject retrieval in online library catalogs and similar retrieval systems? The scope of the answer is limited to automated system experimentation and design. The focus is on function, what OPACs should be able to do, and not on any specific cataloging or indexing practice or use of one thesaurus over another. The framework of the problem is this: generating (either the user or the system) an appropriate set of query terms that represent the concepts central to the user's information need (which may be vague or may change); terms that can match or can be linked or transposed to terms in the system's vocabulary used to represent names and topics in the document collection; joined by the best selection and use of available query-matching procedures and retrieval methods based on relevance feedback gained through the active participation of the searcher at key points in the matching-retrieval process. We have reached the limits of the metaphor of fishing by the waterside.

One approach is characterized by the use and evaluation of automatic or semiautomatic query/index term matching and retrieval algorithms. Included are various term stemming, term weighting, and document ranking techniques. Also in this research and development category are automatically applied combinatorial and combination search methods. These approaches attempt to find "closest" matches to query terms in a more flexible way than Boolean methods permit, or automatically pursue alternative search strategies when initial attempts fail or their results are rejected by the searcher. OPACs with these capabilities include CITE, OKAPI, LIBERTAS, and LCS/WLN at the University of Illinois.

Another approach involves some degree of automatic linguistic analysis of the user's query language at various levels (e.g., morphological, lexical, syntactical, semantic) and often further processing of this language against intermediate, special purpose dictionaries/thesauri linked or net-
worked to the system's indexing language. This approach has been used by ERLI, the French firm that has developed a natural language "front-end" to RAMEAU, the online subject authorities file. In this category also is the Middlesex Polytechnic University OPAC research (sponsored by the British Library Research and Development Department) which is using PRE-CIS headings and words rearranged in a number of ways to serve as an end user "lead in" vocabulary/dictionary with appropriate linkages to the bibliographic records (mostly UK MARC).

Another approach focuses on improved display designs and user interaction devices including the use of windows and graphic presentations of structures of thesauri. The aim is to interpret and present complex file, record, and thesauri structures and arrangements in a way understandable to end users unschooled in the special practices and tools of the cataloger or indexer. The attempt is also being made to make displays function as discovery windows to the collection and related items for browsers. The efficient, linear path of searching through a precise name or subject term is seen no longer as the paradigm of searching but only one way of exploring the collection (Miller & Tegler, 1986).

Another approach, or an extension of the earlier discussion, uses navigation and relevance feedback methods and facilities that exploit the user's response to retrieved data or records to refine the search results, or to guide the user to additional, potentially relevant documents related in some way to one or more records already presented to the user. There are two assumptions underlying this approach: users know what they want more clearly after they see it, and authority or other linking data or mechanisms are better understood in the context of what they actually do. OPACs reflecting some part of this approach include CITE, TINMAN/ TINlib, and SIBIL. Of particular interest in SIBIL is the tree searching capability and the "Tarzan" feature. Searchers can grab onto a data element in a displayed record and use it to swing over to predefined related records without having to reinitiate the entire search process.

Already mentioned is the expert system, rule governed, knowledge base approach. Work on library retrieval systems is slight and is confined to academic research at this time. Success has been limited to small, well-defined subject domains and a restricted set of queries. There exists some skepticism regarding the feasibility of expert systems in large, heterogeneous user/query/collection environments. As Croft (1987) reminds us: "Implementations of information retrieval systems, whether 'intelligent' or not, should address the important issues of IR, which include handling large numbers of documents in broad domains" (p. 253). Examples of special-purpose bibliographic/reference retrieval systems include the British Library's experimental PLEXUS system and Ohio State University's "EP-X" system. Theoretically, one approach to solving the large,
mixed-subject domain found in library bibliographic database environments is to extend the concept of "parallel processing." A number of expert systems could be made available to assist different users bringing different search needs and requirements to the OPAC. Once the subject need and related information needs of the user have been established, automatic mechanisms could "switch on" the appropriate "expert." This would be something like placing a pool of reference librarians and bibliographers at the disposal of the OPAC searchers. Exploiting existing classification schemes and thesauri, the "experts" could even be made to communicate with one another when, for example, the information need is interdisciplinary. It appears that Croft's "IR" experimental system at the University of Massachusetts is testing this extended expert approach (Croft & Thompson, 1987).

By way of summary, advanced IR and OPAC systems have already demonstrated the feasibility and desirability of supplanting conventional inverted file, Boolean logic retrieval systems with systems that incorporate natural language query processing capabilities, linguistic analyses, closest match combinatorial or combination search strategies, ranked output based on term weighting or user feedback, and navigational features based on more flexible and diverse database design techniques. The latter makes it possible to pre-establish multiple, bidirectional links between any data element or record in the database. These links can be coupled with intelligent dialogue screens to guide or lead the searcher through any desired pathway or trail through the library database/collection. Far more is now possible than bringing all the works of a single author together or gathering all citations in which a particular subject heading is attached. These techniques represent early forms of collection navigation in a highly constraining physical environment, namely, the card catalog. State-of-the-art common sense and intelligent IR techniques can be employed to expand and diversify access to and use of today's bibliographic databases (taken in the broadest sense to include catalog records, classification schemes, thesauri, and other authority files). It is necessary for system designers to stop looking backward to the DIALOGs and ELHILLs and to heed the proven advances of IR and OPAC research.

CONCLUSION

The fully extended OPAC or even the "full collection access instrument" does not yet exist in a particular operational environment. In describing the extended OPAC, the summative aggregate point of view has been assumed. Each enhancement or extension mentioned can be found somewhere in one variation or another making synthesis by this writer an
easy task. Demand, ingenuity, and the open-ended technology account for
the recent rush of new access and service-oriented developments. The road
to the common everyday extended OPAC will be traveled in time, but due
to technical and economic obstacles, progress will probably occur in
incremental stages. Overcoming all the obstacles will require considerable
effort, and, in some cases, cooperation on the part of system designers,
vendors, and librarians.

Among the “technical” problems to be resolved are:

1. A variety of incompatible record formats are found in different biblio-
graphic databases. This presents a problem for the integration of
acquired non-MARC bibliographic files into a MARC database. The
database management software of today’s OPACs is designed to per-
form optimally with MARC records.

2. There is inconsistency of indexing and access points across different
data files. The OPAC may provide a uniform set of search protocols to
be used across the data files, but what kind of data element is indexed
and made searchable may vary from file to file. This presents a special
problem for subject searching as different data files may employ differ-
ent thesauri to control the subject vocabulary of the files. A short-term
problem is, of course, that OPACs have no thesaurus handling capabili-
ties and no thesaurus based searching features. It makes little sense to
load Medline or ERIC files into these OPACs.

3. Most of today’s OPACs are linked with a fully functioning circulation
control system or come as a package of functions in the “integrated
library system.” However, the processing performance strengths of
these linked or integrated systems are not associated with the special
requirements of searching and retrieval activities in a large complex
bibliographic database. Typically, these systems are fine tuned to
optimize circulation transaction processing, not Boolean or full-text
retrieval.

The extended OPAC will cost more. Some of the cost increases will be
associated with the resolution of the technical problems mentioned. The
increase in cost for additional data storage may be negligible, but acquir-
ing the amount of computer processing power to maintain acceptable
performance and response time in the extended OPAC will significantly
increase the cost of the system. OPAC expansion will also incur major
development and maintenance expenses. Integration of new functions and
files into the OPAC is a complex matter requiring long periods of work by
highly skilled individuals. Software maintenance rises proportionately
with the increased complexity of the system. Lastly, data files acquired
from commercial sources, such as the abstracting and indexing services,
cost money, and special licensing agreements must be constructed. Some
OPAC owners and managers have the tools and resources now to integrate periodical and citation indexes into their catalogs but simply cannot meet the price demanded by the major commercial suppliers of index and book review data files.

These obstacles to the one stop, self-service, information access and delivery station (or the "scholar's workstation") will be overcome in time. Given a common vision and collective efforts it cannot fail to happen. The OPAC has truly created an avalanche of possibilities and unleashed our imaginations.

REFERENCES


