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SYSTEM DESIGN AND CATALOGING MEET THE USER:
USER INTERFACES TO ONLINE PUBLIC ACCESS CATALOGS

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ABSTRACT

Current research on user interfaces to online public access catalogs is reviewed in an attempt to identify research methods and findings applicable to the design of effective user interfaces to online public access catalogs. A broad definition of user interface is employed which includes data structures, in addition to searching and indexing software. The following features of on-line public access catalogs are discussed: the demonstration of relationships between records, the provision of entry vocabularies, the arrangement of multiple entries on the screen, the provision of access points, the display of single records, and the division of the catalog into separate files or indexes. For each feature, user studies and other research on online public access catalogs are reviewed and those findings summarized which provide insight into user needs concerning that particular feature; issues are identified and directions for further research are suggested. Implications for cataloging codes and standards and system design are discussed.

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I. INTRODUCTION:

With the advent of computer systems designed for direct use by the general public, the need has become apparent to design interfaces which contribute as much as possible to ease of use and ready learnability of these systems. Online public access catalog (OPAC) systems have been no exception. A phenomenon of the last decade, for the most part, most existing online public access catalogs began as technical processing or circulation systems designed for use by library staff [251, p. 10]. Some make use of information retrieval software originally designed for use by professional intermediaries, rather than end users. When these systems were being used by staff only, considerable training could be assumed, and the fact that it took some time to learn to use them was not as much of a problem as it became when the systems were made available to untrained casual library users without the time or the willingness to submit to extensive training.

There seems to be some confusion in the literature as to what is meant by the human-computer interface. Apparently, the term was originally applied to that portion of the applications software with which the system user came into direct contact. Lawrence, Matthews and Miller offer perhaps the clearest definition of the human-computer interface from this point of view:

Interface features are those that involve the "user interface," the interaction between the user and the online catalog system. Examples of interface features include: search method, ... display formats, ... online assistance and instruction....The salient characteristic of interface features is that they are generally created in a layer of software that lies between the user at the terminal and the actual search and retrieval mechanism of the catalog. The interface "software" exists to translate the user's entries into search and display commands that the catalog system can use, and translates and formats computer results into a form that the user can understand.

It should be possible to add, change or remove interface features without changing the basic structure of the online catalog system. To clarify the distinction: interface software can be modified to change the way (or to add new ways) that the user enters a subject search, but adding subject search capabilities where they do not already exist requires significant structural changes beyond the scope of the interface software. [155, p. 413]

According to this view, then, the user-computer interface is simply part of the software, and does not include hardware, or data structures. Taking a broader view, Moran writes:

Psychologically, the user interface is any part of the computer system that the user comes in contact with--either physically, perceptually, or conceptually....The user interface is more than an add-on component; it penetrates deep into the computer system. The user interface must be considered early in the design process if it is to be really designed and not just happen. [223, p. 5]

Is the data structure part of the interface? In the first, narrower definition of user interface cited above, search method and display formats are mentioned as being examples of interface features. Search methods and display formats are both heavily dependent on data structures. Let us consider a concrete example. Those whose job it is to help users find their way through large alphabetical files of names have known for hundreds of years that a common mis-citation involves names beginning with 'Mc' or 'Mac'. In manual card files, the solution to the problem was to interfile all these names at 'Mac', with a cross reference to refer users there from 'Mc'. Thus, even if a user

had a mis-citation, he or she would find the name sought, possibly without ever becoming aware of the misspelling. In online systems, several solutions would be possible, if it were desired to aid users with this problem. The software could be designed in such a way as automatically to search both 'Mc' and 'Mac' names when a 'Mc' or 'Mac' name is input as part of a search query, and to arrange them together on display; or, the data itself could be structured to deal with the problem; for example, catalogers could create authority records for each 'Mc' or 'Mac' name containing a cross reference from the variant form.. (These do not exhaust all possible solutions, of course, but are offered merely as examples for illustration purposes.) From the user's point of view, either solution to the problem results in the face the system presents to him or her. It is irrelevant to the user whether the solution is part of the software or part of the data structure. This is not to suggest that one of the solutions may not be preferable in terms of reliability, efficiency, or clarity of the user-computer dialogue, but rather to suggest that design of an effective user-computer interface requires effective design of the system as a whole, including relationships and structures inherent in the data itself. This is especially true in the case of OPAC's, made up as they are of cataloging records created, by means of a great deal of intellectual effort, largely for the purpose of demonstrating relationships to users; relationships such as those obtaining between 'all the works on a particular subject,' 'all the works of a particular author,' or 'the item retrieved and a newer edition of the same work.'

So far, there is little theoretical literature on online public access catalogs per se. Some user studies have been done, most notably the extensive national study conducted under the auspices of the Council on Library Resources (CLR). There is some literature on system design, which tends to appear in publications of the Library and Information Technology Association (LITA) and the American Society for Information Science (ASIS). There is also some literature on cataloging in the online environment which tends to appear in Cataloging & Classification Quarterly and publications of the Resources and Technical Services Division of the American Library Association. There is

little evidence in the literature, however, that there is much communication between record designers (i.e. catalogers), and system designers. It is hoped that, among other things, this paper will encourage more communication by demonstrating where their concerns overlap.

OPAC features discussed by writers on user interfaces can be divided into three categories, based on the degree to which they interact with existing national standards for record design; only one of these categories will be dealt with here, for reasons to be given below. In the first category are features that can be left as a matter of local option, and do not require the creation of new national standards or the revision of existing standards. Examples of features that can be left as a matter of local option include use of interactive graphics, voice input and output, help displays and messages, error messages, response time, and logon/logoff protocols. There is no reason for every library to offer users the same HELP messages. A second category consists of those features that are relatively independent of existing national standards. Command language is an example of the latter. While an attempt to create a new national standard for command languages is presently being made [30; 38; 97; 98; 224; 232, p. 34], this attempt should be able to proceed independently of existing national standards for record design, such as MARC, AACR2, Dewey, LCSH, and the LC classification. A third category of features consists of those features that do not exist independently of existing national standards for record design. Examples are displays (short vs. full records, as well as filing order of displays), indexing, search mechanics, user-computer dialogue (menu, command, form fill-in, etc.), demonstration of relationships between retrieved documents and others in the database, automatic error correction, and weighting and ranking of documents. All of these features operate upon descriptive cataloging records and descriptive and subject access points that have been prepared, chosen and structured according to various national standards. Every day more records are produced according to existing national standards and loaded into OPAC's. If the records we are creating are causing problems at the user interface, or if there are user interface problems that could be better and more efficiently

solved by programming than by individual decision-making on the part of catalogers, research to demonstrate this, careful thought to devise the best solutions, and efforts to begin the cumbersome process of revising existing national standards cannot begin too soon. For this reason, this review will concentrate on OPAC user interface features that are influenced by record design.

Camp et al. have found that only slightly over 12% of academic libraries have online public access catalogs, but 65% currently without an OPAC plan to implement one [20, p. 344]. The improvement of user interfaces could benefit the users of all these future systems.

In the following review, we will consider the implications of previous user research for both system design and record design affecting each interface feature, and try to suggest possible further research. User problems with OPAC's reported in the catalog use literature have been summarized in a numbered list in an appendix and will be referred to by number in the following discussion. This has been done because user problems tend to be more general than the specific features designed to deal with them; one problem may be solved in a number of different ways, by means of effective design of a number of different features.

II. SPECIFIC INTERFACE FEATURES OF ONLINE PUBLIC ACCESS CATALOGS

In this section, we will examine particular interface features of online public access catalogs. All the great cataloging theorists from Panizzi on have argued that the main function of the catalog was to demonstrate to users relationships between various items in the collection cataloged. There is evidence that users agree with these theorists. The NYU study asked users of both card and computer catalogs to define a successful search in their own words, and 13% of the computer catalog users, and 19% of the card catalog users stated that finding something more than they were looking for was a criterion of success [145, p. 109, 127; 279, p. 18]. Disturbingly, Walton, et al., report user concern over a loss of serendipity in the switch from card

catalogs to online catalogs [300, p. 392]. Hildreth predicts that third generation OPAC's will help users find materials related to those already found [96, p. 654]. See also Crawford [51, p. 160] and Mandel [176, p. 19].

A. THE DEMONSTRATION OF RELATIONSHIPS: AUTHORS AND WORKS

Findings of previous user studies: Previous catalog use studies have studied how often users seek works on a subject as opposed to seeking so-called 'known items.' However, no previous studies have asked how many 'known item' searchers could use any available edition of the work they seek, and how many would need to be able to browse through records for all available editions of the work they seek in order to choose the one best-suited to their needs. We also do not know how many 'known item' searchers seek works that exist in more than one edition, although we can postulate that works that exist in more than one edition are more likely to be sought than single-edition works; at any rate, the publishers of multiple-edition works obviously expect them to be more popular than single-edition works. Another relevant question would be that of how often users seek works by authors who have written more than one work. Another would be how often subject searchers benefit from being shown all the works of an author; after all, the works of a particular author often bear a kind of subject relationship to each other, as when the author tends to write in a particular field. Because studies of such questions have never been done, we do not know how many 'known item' searchers benefit from catalogs that demonstrate to the user the relationship between all the works of an author, and all the editions of a particular work.

It should be remembered that problems that users may be having with discerning relationships in the catalog would be particularly difficult for them to self-diagnose; they do not know about the things they didn't see, but would have found useful if they had.

Record design solutions: Traditionally, catalogers have chosen main entries and done authority work on the names of authors and works, in order to create

catalogs that demonstrated bibliographic relationships to users. These techniques are ultimately dependent on the alphabetic arrangement of multiple records, and the alphabetic matching of identical headings. Currently, all online catalogs rely on these old alphabet-dependent techniques in order to demonstrate bibliographic relationships to users.

System design solutions: Some existing systems make it as easy as possible for users to explore alphabet-dependent relationships, by allowing a user to select an entry on a retrieved record to obtain further retrievals; among these are BLIS (Biblio-Techniques, WLN), NLS at the University of Wisconsin, Madison, and TINMan [92, 114, 115, 124, 226, 227]. However, these systems still require alphabet-dependent matching (they retrieve all records with the heading selected), and they rely on users knowing enough to use the feature. It is possible that mechanical linking techniques that bypass the alphabetical matching of identical headings might enable us to do a better job of serving the user looking for a work represented by more than one record [81, 82, 83, 84, 168]. The HYPERCATalog Project described by Hjerppe may be moving in this direction [114A, p. 102]. One can envision a catalog that could tell a user looking at a particular record that a later edition, or an English translation, or the same serial work under another title is available, even though the user's search did not retrieve the later edition or the translation or all the issues of the serial work [10, 70, 91]. Perhaps the job of the cataloger of the future will be to maintain such mechanical links in a local online public access catalog, rather than to create the individual records in such a way that they will come together alphabetically.

Directions for research: The availability of transaction logs opens up the possibility of investigating the above questions more fully than we have ever been able to before. The main drawback in the use of transaction logs is our inability to know for sure what the user was looking for, and the inability to determine which retrieved items were judged relevant by the user. Kaske, et al. recommend the development of techniques to allow questionnaire administra-

tion after a search, the transaction log for which can be captured along with the questionnaire [129, p. 33]. Larson and Graham report that the MELVYL™ online catalog has the ability to link an online administered questionnaire with the transaction file in which it was administered [149]. Perhaps one could even dream of the search that could be conducted within a questionnaire, i.e. a questionnaire that could be triggered by an actual search, that could then become part of the questionnaire. One could envision, for example, a study of the use of pseudonyms, in which a sample of access point fields involving pseudonyms were labelled ahead of time, and users whose searches accessed these fields were asked to choose the records in which they were interested within an online questionnaire. In this way, one could study how often users searching under one pseudonym end by choosing a work written under another pseudonym, i.e., how often users benefit by the demonstration of the relationship among all the works of an author regardless of the form of name on the title page.

Another question for research is the question of the ideal set of co-occurrence rules for users' searches. This may require some explanation. Currently various keyword access systems assume that when a user's search includes more than one term, these terms should co-occur within a single record. Other systems assume these terms should co-occur within a single heading. The MELVYL™ online catalog, which matches a user's search terms against both authority records and bibliographic records, in effect looks for co-occurrence within a set of records. This makes it more likely that a user who has a citation with an author name or title word that varies from those found on the title pages of the items in the collection will be led to the desired work. If, as many cataloging theorists have argued, many users are looking for a particular work (represented by more than one record), rather than for a particular item (represented by just one record), the ideal set of co-occurrence rules might in fact involve co-occurrence of keywords within a set of records, following the MELVYL™ online catalog's example. The determination of which records might usefully be searched as a set would require research into users' perceptions of when two items represent versions of the same work, when they

represent copies of the same version, and when they represent two unrelated works. Some work of interest in this context is currently being done to facilitate record merging in large online union catalogs [47, 48, 49, 94, 172, 174, 305]. To date, however, this work has not been based on user studies.

B. THE DEMONSTRATION OF RELATIONSHIPS: SUBJECTS

Subject access is another mechanism for demonstrating relationships between records in a database. In this case, the objective is to help users find works that are related to each other by virtue of the fact that they are on the same subject, or on related subjects.

Findings of previous user studies: Contrary to some reports, the CLR catalog use studies did not demonstrate conclusively that subject searching predominates over other kinds of searching; for one thing, 'author-subject,' 'title-subject,' and 'author-title-subject' searches were counted as subject searches, although it seems probable that many such searches were known item searches [294, p. 146; see also 51, p. 174]. Nevertheless, it is clear from CLR findings that subject searching is desired and used by our patrons. Lipetz seems to have demonstrated that one impact of the introduction of on-line searching at the New York State Library was an increase in subject searching [162]. A number of the problems users are having with online public access catalogs are problems with finding works that are related to each other by virtue of the fact that they are on the same subject, or on related subjects. For example, users have trouble finding subject terms, and they have difficulty in increasing and reducing the results of their searches. (See problems 1, 2, and 6 in the Appendix.) Svenonius provides a good review of previous research concerning the advantages and disadvantages to users of controlled vocabulary vs. free text. Controlled vocabulary systems, of course, generally incorporate some sort of structure to relate one term to another, while free text systems leave it to the user to think of all possible synonyms or related terms [see also 4]. Many writers and researchers conclude that the

best approach is to provide both [26, p. 22; 39, p. 84; 276; 281]. Markey and Demeyer report on the Dewey Decimal Classification Online Project, an evaluative study of a prototype software system to allow searchers to search online public access catalogs by means of Dewey classification numbers [184, 185, 190, 193, 198, 199, 200, 201; see also 176]. The DDC Project is a pioneering project in many ways; however, it is unfortunate that it was able to evaluate just one software system, and that a rather complex one. I had trouble understanding the differences among the various available searches myself, and I have some experience with bibliographic systems. This fact means that it is difficult to differentiate difficulties users had with subject access via classification from those they may have had with this particular software application. The DDC Project is valuable, however, in pointing to the need to try to develop effective software to guide the user through the complexities of a classification system. Some of the findings of the DDC Project provide insight into users' needs for the demonstration of subject relationships, whether by means of classification or of alphabetic subject headings. For example, Markey reports that a number of users expressed a need to see a list of terms related to the ones used initially [189, p. 42]. She also reports that 37% of patron-entered terms were more general than their expressed topic, and 13% were more specific [189, p. 43]. There is a good deal of evidence, then, that users do need to be given some mechanism to allow them to move easily to terms or concepts broader or narrower than the ones they begin with. There is also some evidence that users find classification schemes more difficult to understand and use than alphabetical lists [77A].

Record design solutions: Those users who are knowledgeable about existing subject access systems derive a great deal of bibliographic power from their ability to find broader or narrower terms, move from alphabetic indexes to a classified arrangement, and then move about in the classified arrangement, or move from free text terms to a controlled vocabulary. However, concepts such as 'broader vs. narrower' or 'controlled vs. free text' can be very difficult to impart to casual users of an online catalog; the vocabulary we use to dis-

cuss such concepts will be unfamiliar to most catalog users, although many of them may be able to observe such relationships without having a vocabulary to refer to them. Heretofore, we have been dependent on mechanisms such as 'see also' references and numerical classification systems to record relationships such as that between a broader and a narrower term. It is possible that these mechanisms have not communicated these relationships very well in the past.

Alphabetic order has never been the ideal tool for organizing information either chronologically or geographically, since both geography and chronology are actually infinitely divisible continua. The MARC format currently has fields in which coded geographic and chronological coverage information can be stored [25, p. 129]. It is possible that these could be used to allow users to navigate through time and/or space more easily than can currently be done using LCSH subject headings. Such geographic/chronological access would require both record design and system design work, of course. One could envision a system that would allow a user to travel about on a map and set a clock in order to retrieve appropriate documents.

System design solutions: Online systems offer us unparalleled opportunities to enable users to tap the power inherent in the structures we have built into our subject access systems. The hierarchical structures of our subject heading lists, such as LCSH and MeSH, and of our classification schemes, may provide a way to guide users toward works on broader or narrower topics by means of on-line suggestion screens or menus [77A], by means of maps of subject relationships [114A, 215, 216], or by means of explode commands such as those available on MEDLINE and other A&I services [204, p. 52]. We need to develop software that allows the user to discover the relationships among subjects without having to predict them ahead of time, and that as much as possible explains by example, rather than requiring the user to use or understand unfamiliar bibliographic vocabulary. CITE is an example of an innovative system that follows this approach [59, 60, 61, 62, 63]. BLIS (Biblio-Techniques, WLN), NLS at University of Wisconsin, Madison, and TINman have been mentioned above; subject headings attached to a retrieved record may also be selected by

users for retrieval of further records [92, 114, 115, 124, 226, 227]. Stephen Walker is experimenting with the use of the Dewey decimal classification to show users works related to those they have already judged relevant, i.e. for relevance feedback [140, p. 626]. Geller and Lesk report on a user study of a system that features hierarchical menus of Dewey classification numbers, and that allows a user to move from a subject heading to the classification menu at that spot with a single letter command. HYPERCATalog is planned to incorporate links and relations between fields, records and files [114A, p. 102], and to provide access to classification systems and thesauri in the form of maps [114A, p. 109].

Since current practice is to choose as the first subject added entry in a bibliographic record that subject heading that is most co-extensive with the work cataloged, major and minor topics covered by a given work are somewhat cryptically encoded as such. This might allow us to offer users the option of narrowing searches to works primarily concerned with the topic of interest.

Directions for research: Because of the weaknesses of the DDC Project discussed above, further research on the value to users of making the classification numbers in bibliographic records accessible to them online is needed, as is further research on more user-friendly ways of helping users use classification access effectively. It should also be remembered that the DDC project evaluates just one of many classification schemes [23, 176, 282, 306]. Comparative studies of several classifications online might provide more insight into whether or not one is superior to another for purposes of providing online access. We also need to do more research on our existing subject access systems to see if there are ways they can be improved or should change to adapt to new technology. Should not our classification practices change, for example, if we decide to use our classifications to produce true online classified catalogs, rather than offline shelf locations? Janet Swan Hill points out many ways in which current practice produces a less than optimum set of classification numbers for online searching [110]. Markey reports that one of the sources of user problems with Dewey decimal classification search-

ing in the DDC Project was the fact that a record can contain several very specific subject headings and one more general classification number; thus, a user's search for a rather specific subject could be matched to a very general classification number; in a true classed catalog, each subject heading would be accompanied by an equally specific classification number [193].

Some systems ensure that any subject search results in display of the index. Some display the index only when a user's search matches more than one term; otherwise, users are shown bibliographic records. Other systems require the user to give a separate command to search the index rather than the bibliographic records [51, p. 164-166; 178, p. 69]. Research could be useful to determine whether or not automatic display of the subject index in response to any subject search improves the user's ability to observe useful subject relationships, to move from broader to narrower terms and vice versa, and to experience serendipity. Such research should also examine how often users find such automatic display to a no-match search more confusing than helpful; some users may mistakenly consider the display itself as evidence that their search matched each heading displayed.

C. THE MATCHING OF ENTRY TERMS TO USED TERMS

In order to "talk" to a machine, one must be able to specify more than when one talks to a human, and whatever is specified must be rigorously accurate. All assumptions must be expressly stated. This is not a new problem; use of the card catalog was not the same as talking to a person either. The manual catalog always presented problems to the user who came to the catalog with an inaccurate or incomplete citation; once there, the user could easily fail to recognize the operation of fairly elaborate filing rules designed to keep large files of bibliographic records in reasonable order. However, the linear alphabetic file only requires the user to "specify" (by flipping through cards) letter by letter up to the point that a small file of recognizable entries is reached. The records always in front of the user's eyes provided constant feedback on the success or failure of the search. The computer, on

the other hand, requires the user to type in search terms letter by letter; each letter added to the search, while it decreases the likelihood of retrieval of unmanageable numbers of records, increases the likelihood of a typographic or spelling error, which, in talking to a machine, is devastating. This must be done on a blank screen; feedback arrives only after the search has been sent to the machine for execution. One might expect, then, that the problems users have always had guessing what we might call something or remembering what it called itself would be exacerbated in online public access catalogs. (It is for this reason that many online systems are now allowing, and even requiring, users to browse alphabetic indexes.)

Findings of previous user studies: Many of the difficulties reported in the literature indeed seem to be related to the problems of matching entry terms to used terms described above. Difficulty finding subject terms (problem #1, Appendix), difficulty in increasing results (problem #2, Appendix), typo's, spelling errors, etc. (problem #10, Appendix), fullness problems with abbreviations and initials (problem #12, Appendix), problems with spacing and hyphenated words (problem #14, Appendix), and difficulty understanding see references (problem #19, Appendix) have always been problems for users trying to use catalogs, but may be exacerbated in many online systems that do not try to compensate for these difficulties in some way. It should not be forgotten that all user studies done so far have been done on online public access catalogs that did not have any of the cross references in LCSH available for searching. Markey reports findings from transaction logs from several different systems that indicate high percentages (35-58%) of subject searches resulting in 0 postings [197, p. 601]. It is unclear, however, how often 0 postings were due to confusion about how to use the online system correctly rather than inability to match a subject heading in LCSH. In contrast, Markey did a transaction log LCSH matching study of SULIRS at Syracuse in which 86% of users' searches included a search statement that either exactly matched an LCSH term or cross reference, or was a close variant; (each search included an average of 4.6 search statements) [195, p. 65]. As Markey points out, however, figures merely reflect the fact that at least one item was retrieved; it is not possible to determine how many retrieved items were relevant. Carlyle has done a transaction log study of ORION (UCLA) prior to the loading of LCSH cross references and discovered that 47% of searches matched LCSH exactly and 48% of searches resulted in partial matches; only 5% of searches resulted in no match [21, p. 27]. ORION provides keyword searching of a subject heading index. These studies would seem to indicate that LCSH matches user terminology more successfully than has previously been thought, especially when keyword searching is available. Their findings should be contrasted with those of Geller and Lesk; their study in a scientific library found that 72% of the terms searched for were in titles, and only 36% were in subject

headings; this is a subject area in which LCSH is known to be weak.

Hans Ove Frid's study comparing the performance of a COM catalog and an online circulation system suggest the value of the ability to browse indexes in online catalogs. Assigned searches were given to eight subjects, who searched them in both the COM catalog and the online system. Findings were that "The online catalogue was faster than the COM catalogue in all kinds of searches tested. With regard to accuracy of searching, both catalogues performed equally well when searches were for correctly cited names. But the online catalogue produced twice as many incorrect answers as the COM catalogue when the names were incorrectly cited" [73, p. 20]. In the DDC Project, the ability to browse up and down an alphabetical list of subject headings increased users' retrieval of relevant items dramatically compared to the number of relevant items retrieved on the basis of a match to the initial subject heading search [189, p. 40].

Golden and Golden investigated the performance of search keys vs. the performance of keyword searching in searches for the same serials, and found that search keys produced smaller retrievals. The search measure was simply the number of hits, and the two databases searched were not the same size, but the larger database was the one searched by search key, so perhaps the finding that search keys produced fewer matches has some validity for the searching of similar titles or titles containing nondistinctive words [79].

Record design solutions: In the past, catalogers have inserted cross references in their files in an attempt to anticipate some of the problems described above. Our rules for cross references are coming under some scrutiny now, because of the awareness that many cross references currently being made are not necessary in various specific online public access catalogs, because of the normalization and matching rules followed by the searching and indexing software. Taylor matches actual author searches that resulted in no hits (on LUIS at Northwestern) against the LC authority file (and her own knowledge of what the LC authority file would contain, if a name had been established by LC) in order to determine how often the integration of cross references called

for by current rules would have resulted in search success. She finds that only 6.4% of the no hit searches would have been successful if the postulated cross references had been present. Two problems decrease the value of the results of this very interesting study. One is that a sample of no hit searches misses all those searches where the user found something, but not what he or she was seeking; for example, the user who found a Fred Jones, but not the one he or she was looking for, was not in the sample. This means the sample is probably biased toward fairly unusual names, and away from common names. Secondly, the no hit searches occurred on a particular system (LUIS) with particular features. As Taylor herself demonstrates, 21.7% of the no hit searches were due to the fact that on LUIS users must input personal names in inverted order; since this is not the case on many other systems, the system itself introduces considerable bias. (The author knows of at least 12 systems on which uninverted personal names are valid searches.) Nevertheless, the study represents a very interesting attempt to evaluate the amount of help current record design practice can give users with their entry vocabulary problems [286]. Thomas has investigated the number of cataloger-created cross references to names that serve no useful purpose in the MELVYL™ online catalog, which is searchable by keyword, and has found that 47% of the cross-references catalogers now routinely make for manual files could be dispensed with for the MELVYL™ online catalog [287]. Watson and Taylor attempt to evaluate the number of cross references in current LC name authority records which would be necessary in systems that provide both automatic right-hand truncation and keyword searching, and find that 82.8% of current name authority records either have no cross references or have cross references that they consider unnecessary [302]. Not everyone would agree with the categories of references they consider unnecessary, however; included are variations from the heading in forename fullness, and word order inversions. A cross reference from 'Smith, John D.' to 'Smith, J. D. (John D.)' could be quite helpful to a user scanning a list of all the headings retrieved by the keyword search 'John Smith.' Cross references from word order inversions can also be helpful in keyword access systems or in browse files when one must

scan a number of retrievals. Jamieson et al. find that slightly more than 50% of name cross references and almost three-quarters of subject cross references on current LC authority records are not found in title page transcriptions in bibliographic records, and hence the availability of keyword searching is no substitute for the provision of these cross references [125, p. 279].

It would appear that, because each OPAC is following different normalization rules for searching and indexing, and different filing rules for arranging retrieved headings or records, the cross reference rules cannot yet be optimally standardized. The situation is further complicated by the fact that the majority of libraries do not yet have online public access catalogs, and perhaps many of them will never be able to afford them [6, 20]. Card and COM catalogs still need cross references designed for linear alphabetical sequences of headings.

Cochrane reviews recommendations for improving the cross reference structure in LCSH [36]. Bates recommends increasing the entry vocabulary in LCSH [71].

System design solutions: Many systems have attempted solutions to the problem of matching user input to records in the system. Some systems allow users to browse up and down index files, looking at headings that may not necessarily have matched their initial searches (for example, CLSI's PAC II [93, p. 177], and ORION). Some systems, such as the MELVYL™ online catalog and ORION, allow key word searching of controlled headings, to enable users to identify controlled headings more easily. OCLC has indexed all Mc and Mac names the same way; both McDonald and MacDonald are searched in OCLC search keys as MDON, and users are shown all McDonalds and MacDonalds that match their searches; OKAPI indexes all such names as 'Mac' [218, p. 63].

Many system normalization rules are rather arbitrary, and vary from one system to another. For example, one system will convert a hyphen to a space, so that the word is indexed as two words, and another will delete the hyphen, so that the word is indexed as one word. This seems to be a fruitful area for the development of standards, so as to minimize the number of details a user

has to remember about each OPAC he or she may have to search. Even better would be the development of normalizing programs that employ dictionaries to search for all variants when any one is input; for example, the ideal would be for a search employing either the term 'online' or the term 'on line' to retrieve 'online,' 'on-line' and 'on line.' Apparently LIBERTAS (SWALCAP Library Services, England) can do this [297, p. 86].

Because of the awareness that many users are having problems with typo's and misspellings, some systems offer spelling correction programs. A notable example is BACS at the Washington University School of Medicine [132, 133]. Yannakoudakis describes another spelling correction system [310]. Roughton and Tyckoson suggest the use of sound-based codes that would allow matching a user's search against all words that sound the same [262]. OKAPI offers users whose author searches have failed the option of a search using sound-based codes [127, 299]. Also planned for OKAPI is a small dictionary of alternative (American/British) spellings of words [127, p. 8]. So far no research has been reported on the performance of such programs on large bibliographic files. Have they increased user success rates substantially? What is their effect on the common user problem of retrieval of too many records? Hickey reports that costs would increase markedly if surname similarity algorithms were used on OCLC [95, p. 33].

Paperchase [33] and CITE [59, 60, 61, 62, 63] are systems that allow users to search using any subject entry term; the software matches the search against both free text terms and controlled vocabulary terms, and by means of feed-back menus, encourages the user to take advantage of the power of the controlled vocabulary, without requiring the user to employ terms from the controlled vocabulary in the initial search. LCS/WLN apparently re-searches a failed subject search as a title key word search, asks the user to pick out relevant records, and guides the user to attached subject headings [96, p. 659; 176, p. 10]. OKAPI has elaborate algorithms to give users the closest match when a complete match is not made [127, 218, 219, 297, 298, 299]. Walker provides a frank discussion of the problems users can have with algorithms such as automatic truncation, and points out that sometimes the system

can be forcing the user to continue fruitlessly when the item is simply not in the collection. In general, there are dangers inherent in using algorithms that are out of the control of the user [176, p. 9-10; 232, p. 44-45]. For example, currently, the MELVYL™ online catalog treats some FIN TI searches as keyword searches and others as exact searches; it is frustrating to design and input a search as a keyword search, and then have it fail because the MELVYL™ online catalog decided on its own to treat it as an exact search. One danger in such programs may be that the operations of the software may be a complete mystery to the user, leaving the user feeling powerless to control the system. However, if an explanation of what the computer is doing is readily available to the user at any time, and if the user has the option of 'turning off' the feature at will, such features can go a long way toward sharing bibliographic power with our users.

The online catalog could be used as a mechanism to allow users to request useful cross references. For example, users could be encouraged to write online messages to catalogers whenever they have trouble finding material on a subject. This could alert catalogers to the need for appropriate cross references that might have helped the user. Striedieck describes a similar mechanism on LIAS used to notify cataloging staff of cataloging errors [278]. Tague experimented with a system in which users were allowed to enhance subject access to records [284]. Hjerpe reports that plans for the HYPERCATalog project include providing "each user with the ability to specify, and save, his views of the collection" [114A, p. 107, 109; 115, p. 211].

Directions for research: System designers so far have tended to use at least four different types of indexing programs, which are not easily definable or necessarily mutually exclusive, i.e., one system may use more than one. In addition, it is highly unlikely that these types exhaust all possible types of indexing programs which could be applied to online public access catalogs in the future. The terms used to refer to these four types of indexing programs have not yet stabilized, but currently the most commonly used terminology

seems to be:

- 1) Keyword indexing, in which indexed fields or headings are broken down into words (a 'word' being operationalized as 'a string of characters bounded by spaces'), each of which is separately indexed.
- 2) Phrase indexing, in which a field or subfield is indexed as a whole, with order of terms preserved, such that subsequent matching of search arguments must match both terms and order of terms. (Also known as direct field indexing or exact phrase indexing.)
- 3) Search key indexing, in which a field or subfield is indexed as a whole, with order of terms preserved (as in phrase indexing), but only a fixed length portion of each term is indexed, e.g., the first four letters of the first term, the first three letters of the second term, and the first letter of the third term.
- 4) Permuted indexing, in which a field or subfield is indexed as a whole, with order of terms preserved, as in phrase indexing, but the field is then rotated to bring each separate word in the field to the head of the field.

To get around weaknesses in the nature of access provided by each of these indexing approaches, system designers have employed additional techniques. For example:

- 1) Keyword indexing, because it tends to result in high recall and low precision, may be supplemented by attaching locational data to each term indexed, pertaining to the term's location in a particular field, and/or in a particular record, to allow the use of positional operators in adjacency searching of "phrases."
- 2) Phrase indexing, because it requires an exactitude of match not attainable by most users without extensive look-up's prior to the search, tends to be supplemented with either explicit (voluntary) or implicit (automatic) truncation, allowing searches to match only the first part of the field or subfield indexed.
- 3) Search key indexing, because user-input search keys require a great

deal of rule learning, may be accompanied by automatic search key formulation by the searching program prior to matching users' input against the index.

Because of all these variations in indexing systems, comparisons of various approaches to indexing in terms of usefulness for various kinds of search (subject searching, name searching, title searching, etc.) and in terms of performance on large databases would not be easy. However, it would be useful to attempt to do this. Perhaps recall/precision experiments similar to those that have been employed to test indexing systems in online bibliographic databases would produce interesting results, if they could be applied in experimental software systems that hold all other things equal, and if they could be tested on the same database. The use of the MARC database might be useful here. The fact that all MARC records provide LCSH subject access would enable the subject access system to be held constant. Recall/precision might not be as useful a method for testing known item retrieval as for testing subject retrieval, but it would be interesting to determine if there are variations in the amount of "noise" retrieved in known item searches using each different machine indexing technique. Recall/precision tests should be performed to assess optimum indexing of various kinds of entries and headings, such as title, corporate body, subject and personal name, to see if different kinds of entries and headings require different kinds of indexing. The DDC Project, and Siegel et al. did some recall/precision studies, but in each case the studies compared two quite different pieces of software; once so many different factors are involved, it is hard to isolate the effect of one of them. Hildreth notes that the trend is for OPAC's to offer both "pre-coordinated phrase searching" and "post-coordinated keyword searching" [96, p. 651]. However, this approach creates more complexity for users to master. If one type of indexing is a better default for a particular kind of search, it would be useful to know.

The question of the usefulness of pre-coordination predates the development of online public access catalogs, but the availability of keyword searching in OPAC's is bound to raise the question again [25, p. 126]. As Austin

points out, pre-coordination can express the relationship between two key words; for example, the concept 'children in pornography' can be distinguished from the concept 'effect of pornography on children', if these phrases are pre-coordinated. If, however, indexing is limited to single terms, the relationship between two terms can no longer be expressed; for example, the addition of the searchable terms 1) Children and 2) Pornography to a record for a document about the effect of pornography on children no longer expresses the relationship between the two concepts [4, p. 7].

Existing lists of subject headings, such as LCSH, will often be inconsistent in their use of vocabulary within headings or subdivisions especially over time. For example, LCSH headings containing the terms 'films,' and 'motion pictures' co-exist in the current edition. Because these terms are not headings in their own right, there is no cross reference structure to alert users to the fact that two synonymous terms are in use for the same concept, nor to refer them if they use the term 'movies'. Research on the feasibility of developing normalizing programs using dictionaries to link synonyms might be useful here. Walker reports that OKAPI system designers are experimenting with such possibilities [299]. Apparently this is done by some A&I services [204, p. 49].

Online public access catalogs may offer a new opportunity to study the frequency with which users' terms match our controlled vocabularies. Markey and Carlyle report on transaction log research that has already been done; see above. In order to solve the problem with transaction log research that results from our inability to determine what the user was looking for in the first place, and whether anything found met the user's needs, one could envision a study in which a random sample of users doing subject searches were asked by means of an online questionnaire to describe in some detail what they were looking for, and then to do their first search within the questionnaire, indicating those items that appear relevant, so that the search, and its results were captured for subsequent study.

D. ARRANGEMENT OF MULTIPLE ENTRIES

Findings of previous user studies: One of the problems users are having (#8, Appendix) is that of difficulty scanning through long displays. As part of the CLR study, Lawrence and Matthews point out that the initial display after a search in some systems is a list of headings, while in others the initial display is an array of bibliographic records. They attempt to relate the type of initial display used in a particular system to expressed user satisfaction with searching by subject in that system, and observe that of 13 systems, more systems with an initial heading display were in the top ranking than in the bottom [154, 214]. This seems a somewhat dubious correlation, since so many other variant system features may be affecting user satisfaction. However, it seems intuitively obvious that an initial display of multiple records by the headings matched would be superior to an initial display by main entry of the bibliographic records retrieved; at least, this seems obvious if the records have been retrieved by matching a number of different headings; an example would be if the search term 'power' matches a number of different subject headings containing the term 'power'.

Record design solutions: Catalogers have developed rather elaborate heading structures to ensure that multiple headings arrange themselves in a logical fashion. Unfortunately, some of these structures were designed to function in card catalogs filed by human beings, and assume that a human brain will make the necessary connections. An example is the period subdivision which begins with the name of the period covered, rather than with a span of dates, e.g. 'United States--History--Civil War, 1861-1865'. In card catalogs, human beings would file these in chronological order (after 1850, before 1870), disregarding the alphabetic characters for the name of the period which begin the subdivision ('Civil War'). Most machines file these in strict alphabetical order, thus disrupting the logical chronological order which would be most helpful for users [118]. Whether or not this problem demands a record design solution or a system design solution, of course, is a matter for debate. If

an "intelligent" machine filing program could be developed to arrange these in chronological order, it would save the expense of changing millions of existing records.

One very useful heading structure developed by catalogers is the parenthetical qualifier. The parenthetical qualifier is used when a term or a name could refer to more than one concept or entity, and something is needed to warn users of this fact, and to signal that they need to decide which of several possibilities they are interested in. For example, a political scientist may decide to do research on 'power', and not really consider the difficulties that lie ahead in sorting out the works that use the term 'power' the way a political scientist would, rather than the way an engineer or a theologian would. In a card file, the political scientist could look up 'power' and find the following three headings, one right after the others:

Power (Mechanics)

Power (Social sciences)

Power (Theology)

Unfortunately, it is rare to find an online catalog that pays attention to parentheses. As a result, it is common for the above three headings to be interfiled with longer phrases in online displays; for example, the political scientist would have to look beyond the heading 'Power resources' with all its subdivisions before he would find 'Power (Social sciences)'. The machine forces the user to know about the phrase in parentheses in order to find the appropriate heading. This was never the catalogers' intention; in the card file, the term within parentheses would have been ignored in filing until needed for subarrangement, and 'Power (Social sciences)' would have been filed exactly the same way that 'Power' with no parenthetical qualifier would have been filed. One online system that does ignore parenthetical qualifiers in arranging multiple headings is OCLC's LS 2000.

Catalogers never intended that users should have to be aware of the existence of subject heading subdivisions, either. The intent was that a search on the subject heading alone would retrieve a set of records that was then organized by subdivision to allow easier navigation through them.

Unfortunately, many online systems interfile headings with subdivisions with other longer headings.

It should not be forgotten that another very useful mechanism for the display of multiple records in online public access catalogs is the main entry based on authorship. In an online display of 100 records with the same subject heading, each record can be displayed only once. If it is displayed alphabetically by main entry, the user is thereby enabled to observe a number of useful things in the initial scan through the hundred records; the user can observe which authors have written extensively on the subject, which corporate bodies are active in the field, which works are conference proceedings and which are works of personal authorship. One could even argue that such a display can be a useful substitute for evaluation of the works available, what Patrick Wilson calls 'exploitative control' [309, p. 25]. For example, it is at least possible that a general book by an author who has written extensively in the field would be valuable as an introduction to the field.

System design solutions: MARC records contain a great deal of power which has as yet been untapped by most online public access catalogs. The subfield coding in heading fields is quite elaborate, and can be used to identify various kinds of subject subdivisions (topical, geographic and chronological), and other information, such as birth and death dates for persons. Punctuation, such as parentheses, as described above, has been used rigorously, that is, only for certain prescribed purposes. Sophisticated machine filing systems could use this existing data to differentiate between the characters in headings that should be significant for the arrangement of headings, and characters that should be ignored for primary arrangement, and considered only when two headings are otherwise identical. Some systems already do this. The Library of Congress has published some sophisticated machine filing rules, and LCSH on CD ROM, currently under development, arranges multiple subject headings in useful ways. OCLC's LS 2000 is an online catalog that has very useful displays of headings; for example, all subdivisions are displayed together beneath the heading, rather than interfiled among

other longer headings.

A wonderful power some online catalogs, such as STAR, and some BRS-based catalogs, offer users is that of the ability to select among sort options. For example, a user could choose to display a given set of records by author (i.e., by main entry), by date, by title, etc. One could argue that the provision of sort options would quell debate about the superiority of one method of arrangement over another. However, the provision of options would require a fair amount of computer power, and may not be feasible for most systems yet. Even if it were feasible, a default arrangement should probably be in place for those users who prefer to avoid the complexity of having to choose among sort options.

It should not be forgotten that one method of displaying relationships between multiple records is to design effective displays that reveal these relationships. Lawrence has suggested that multiple screen displays be summarized by means of a directory [151, p. 8]. Such directories could conceivably enable us to return to the elegant layout of the old British Museum catalogs in which multiple-edition works were summarized by language or by editor; a user could quickly scan the various available editions in order to choose the one most suitable to his or her needs. Barbara Tillett has studied the kinds of bibliographic relationships that currently exist among MARC records; this work could be the preliminary to developing a coding system for summarizing multiple editions of a particular work in this way [287A]. Long displays of multiple subject headings might be easier to scan if subject headings could be displayed without subdivisions on initial summary screens, and subdivisions could be displayed once the heading itself was chosen.

Directions for research: A great deal could be done to investigate the usefulness of various arrangements of multiple records for various kinds of search, and, other than the work already cited, little has been done so far. Once again, online questionnaires administered to users who have retrieved multiple records might be useful. If the questionnaire could arrange the records already retrieved in several different ways, and ask the user which

arrangement he or she prefers, some very useful data might result. Interesting results might be obtained from studies of varying arrangements measuring the speed and accuracy of various kinds of search.

DISPLAY OF A SINGLE RECORD

Findings of previous user studies: There is evidence that users are having difficulty understanding codes and abbreviations in displays, especially location and circulation information; (see problem #18, Appendix). However, as Lawrence points out, problems with displays do not seem to be very important to users [151, p. 7]. On the CLR survey, the problem least often checked by users was 'understanding the display for a single item' [294, p. 125].

It is often suggested that labelling of the fields in a bibliographic record aids in user comprehension [53, p. 75; 213]. Only one user study of the validity of this suggestion has been attempted so far. Fryser and Stirling conducted a timing and user preference study comparing LC card format display of bibliographic records with a display with fields labelled. They found that 83% preferred the labelled display. However, their methodology casts doubt on the findings; users were first instructed to identify a predetermined bibliographic field as quickly as possible; presumably, the instructions to the users employed the same terms as were used in the labels on the labelled displays. Then the users were asked their preferences. Predictably, they tended to prefer the format which had just allowed them to be tested most successfully. (For some reason, the figures on how long it took users to identify particular fields were not directly reported) [77].

A number of researchers have attempted to investigate the fullness of description which is needed by catalog users, and the CLR study also contained a question addressing this issue. The approach taken by Seal et al. was to replace a full entry microfiche catalog with a short entry microfiche catalog and then, in interviews, to ask users of the short entry catalog whether they had "found what they wanted to know from the catalogue." Using this methodology, only 1-3% of searches were reported by users to have failed be-

cause of lack of bibliographic description [19; 90; 265; 267; 268, p. 201]. Sheridan and Butcher measured the speed with which a short entry catalog could be searched, and found the full entry catalog was 28% slower for assigned searches; they also note that the full entry catalog was available only on demand, and was asked for relatively seldom [269]. Kinsella reports on another project to measure speed and accuracy in locating information with long and short records [139]. Reynolds and Spencer studied the speed with which users found assigned author headings in brief and full COM catalogs of 1700 records each; they found that searching was faster in the brief catalog; the question of the information needed by the user for decision-making was not addressed [255]. In the CLR survey, among the questions asked users about their most recent search was one asking them what they had been trying to find. This was the question used to determine how many users sought known items and how many sought works on a subject. Among the possibilities offered was "Information such as publisher, date, spelling of a name, etc." The fact that very few users checked the latter possibility has been used by some reporters of CLR findings to argue that "Most users do not express a need for detailed bibliographic information" [153, p. 88]. All of these researchers seem to have lost sight of the fact that the primary function of the descriptive part of the cataloging record has never been primarily to aid in bibliographic verification, but rather to identify or to distinguish among various works, and editions of works, and to characterize them, so as to aid the user in choosing among them. The methodology in most of these studies assumes that users come to the catalog knowing what they need to know, and that if what they need to know is missing, they will notice that fact. In fact, however, users come to the catalog in need of information they do not yet have. If they miss something that might have been useful, they may not know they have missed it, and thus they may not be able to report the fact that they have missed it. Medical research that evaluated a particular drug therapy by asking patients whether they needed it or not would undoubtedly be frowned on. We must beware of doing similar research in our field.

Larson reports on the frequency of use of review, brief and long dis-

plays in the MELVYL™ online catalog based on transaction log analysis as follows:

| TYPE OF DISPLAY | MENU MODE | COMMAND MODE |
|----------------------|-------------------------|-----------------|
| Review (no call no.) | 44.5% (default display) | 6.0% |
| Brief | 14.8% | 66.3% (default) |
| Long | 40.7% | 14.0% |
| Browse | | 9.9% |
| Other | | 3.8% [147]¹ |

While this kind of data may raise more questions than it answers, it is certainly a useful preliminary to more detailed investigations. Frequency of use data, especially in a situation like this where so many choices are available to the user, must be used with caution, unless the researcher is willing to assume that the user always knows what he needs.

Crawford et al. report on extensive experimentation with single-record displays. However, no user testing has been done as yet. Recommendations are based on the opinions of the three system designers who wrote the book [54]. Croucher's research seems to demonstrate that there may be an optimum number of characters on a screen for comprehension and speed of scanning [55, p. 219].

Record design solutions: It is popular nowadays to scoff at the use of the "card format" in online displays; see for example Hildreth [102, p. 51]. However, the card format was originally designed to deal with a problem that does not go away with the advent of online catalogs, that of a shortage of space in which to convey information about a particular version of a work. Computer screens do not offer unlimited space either. Crawford reports 30% of records investigated on RLIN required a second screen using a card-like display, 84% when using a labelled display [54, p. 3]. Also, it should be borne in mind that the card format sets off information by means of paragraphing and indentation rather than by labelling not just to save space, but so as

to avoid the imposition of more arcane bibliographic vocabulary on users. How many users would understand the terms 'material,' 'other entries,' and 'corporate author,' for example? These were all terms used in labelled displays in Crawford, et al. [54, p. 78]. Labelling requires the selection of appropriate vocabulary for the labels. A little experience on a reference desk is enough to lead one to observe that users are not always articulate about bibliographic matters; if, in fact, they have no names for bibliographic fields in their common vocabulary, is it not possible that labels of bibliographic fields would cause more problems than they would solve?

The cataloging literature has always contained discussions of ways to save money on cataloging by creating minimal level cataloging records; one aspect of minimal level cataloging is a briefer description. [For example, 119]. If research determines that all users in all circumstances need briefer descriptions, it might be more cost-effective to cut back on the amount of cataloging done, than to display less of the record; whatever part of the record is never displayed constitutes a wasted resource--cataloging work done from which the user is not allowed to benefit. Also, human intervention would produce better records than mechanical lopping; for example, some nonbook materials without title pages may be nearly entirely described in notes; if all note fields are omitted from display mechanically, these particular records may be rendered virtually useless [54, p. 211].

System design solutions: See above for discussion of the dangers of mechanical shortening of records. Many systems do offer an array of choices for various levels of display. This adds a level of complexity to the system that many users may prefer to avoid; thus it is still imperative that system designers make good decisions about which single-record displays to employ as defaults in various searching situations; for example, one might hypothesize that a fuller description may be more useful to a subject searcher.

Directions for research: With regard to labelling, research on what kinds of bibliographic vocabulary are recognized by most users would be helpful in this

area. Labelling would increase the size of records, and the amount of text to be scanned by the user, so it would be useful to know whether or not it produced a significant difference in the amount of time it takes to scan a record.

It is common for the display of a single record on any given online catalog to begin with information such as record numbers, call numbers, and command lines, rather than with the heading that determines the order in which this record is displaying relative to others that may have been retrieved in the same search. (Crawford et al. refer to such information as context [54, p. 19].) No research has been done on whether or not this is confusing to users, and it would be useful to know whether or not it is.

In talking about displays, it is important to remember Hafter's wise observation based on an examination of a number of important studies of the card catalog: "Users are poorer at articulating what they know about the catalog than they are in manipulating the catalog" [88, p. 207]. Users may observe patterns in the catalog or absorb information from it, without developing any kind of a vocabulary to converse about these things. When reading a cataloging record, they may unconsciously absorb important information in the notes field, but when asked directly whether or not notes fields are important to them, may answer that they are not. They may not in fact realize that the information they just used was in something called a notes field. Perhaps a better kind of research than what has been done so far would consist of letting a given user find a record being sought in an actual user-initiated search, making sure that he or she is seeing the full record, and then asking the user to indicate which pieces of information are useful. It would be interesting to compare the findings for subject searchers with those for users seeking a particular work. One category of users may well find different parts of the description more useful than would another category of users.

F. MORE ACCESS POINTS

Findings of previous user studies: Users' highest ranked problem on the CLR study was that of difficulty in increasing results (problem #2, Appendix). Larson and Graham report on the frequency of use of particular indexes in a particular online catalog (the MELVYL™ online catalog) [149]. This kind of data is useful for revealing how often users are using the various kinds of access points we already provide. Diodato reports that of the terms users used to describe a book just checked out, 72% of the terms corresponded to headings in LCSH, and 81% of the terms were found in the tables of contents of the books in question [58]. This is an interesting attempt to measure the value of adding the table of contents of each book to its MARC record. It has the obvious flaw of examining only materials that have actually been found by users, and failing to examine materials that users were unable to find; nevertheless, the fact that only 9% of users would have been helped by the addition of tables of contents is noteworthy.

Record design solutions: Several writers have suggested that we should increase the number of access points available in our records [31; 34; 35; 36; 40; 41; 96, p. 660; 167; 170], whether by adding more subject headings and more name added entries, or by adding tables of contents and indexes. Mandel has written a good review of all the possibilities for augmenting subject access [177]. Users surveyed in the CLR study, when asked about desirable additional features, ranked second the ability to search indexes and tables of contents [197, p. 56].

Svenonius, Baughman and Molto have done research that indicates that if all names associated with cataloged items were to be made into access points without any human judgment as to degree of responsibility, the number of names indexed per item cataloged would greatly increase, and retrieval precision would be adversely affected [283]. Impacts on cost through increased size of machine indexes, increased searching costs, and increased authority work costs, if done, should be obvious. Rao and Knutson were unable to demonstrate

that circulation of books given many access points was higher than circulation of books given only a few. However, they were studying existing records, not augmented records [142A, 143, 249]. Interestingly, Knutson found that books with many descriptive access points were less likely to be used than those with a few [142A, p. 37]. If this research is duplicatable, it has obvious implications for saving money currently being spent on authority work. Hoffman points out that many works within works are not accessible in our catalogs even though they are in our collections [116, 117]; the solution, of course, would be to analyze more collective works, or at least provide searchable contents notes; this would necessarily increase cataloging costs, though.

Current subject cataloging practice is to follow the so-called 'rule of three;' under this rule, when a work covers three separate topics, each of the three can be given a subject heading. Thus a book about bloodhounds, collies and German shepherds would be given one heading for each type of dog, but a book about bloodhounds, collies, German shepherds and poodles would be given the heading 'Dogs.' At first sight, it would seem preferable to have four specific headings rather than one general heading for the latter book; however, if the library has many books about German shepherds alone, the user interested only in German shepherds would have to sort through more records to find the books about German shepherds alone if the rule of three were to be abandoned. Since online catalog users are having problems reducing their results (problem #6, Appendix), we should beware of the loss of precision that might result from the unconsidered addition of in depth indexing terms to our records. Our databases are growing in size at an astronomical rate, and thus searching precision becomes more and more desirable.

System design solutions: Currently many bibliographic records contain contents notes, summaries, credits notes, and other notes which could perhaps be usefully indexed to supplement access already available. In order not to contribute to the difficulty users are having in reducing results, it would probably be wise to make notes searches optional, and separable from searches on controlled access points. However, indexing notes could sometimes provide

more access than we have traditionally been able to provide.

Directions for research: The advent of online public access catalogs may offer the chance of doing a finer grained analysis of what users look for than the known item/subject dichotomy. Most online catalogs contain MARC records, and in MARC records there are different tags for corporate names, conference names, series, name main entries, and name added entries. Perhaps we could put our machines to work studying how often users' searches are matching these fields, and sampling searches that match these fields to see how often they were being sought, and whether users are having problems with matching that type of heading. The findings could have broad economic implications for where we should invest valuable staff time in the establishment of access points, as well as suggest ways to improve access. For example, in author and author-title searches, how often are users searching using the name of the author primarily responsible for the work(s) retrieved (main entry), or the only name attached to the work(s) (single personal name added entry), and how often are they searching for the names of authors after the first? Are we being generous in our practice of establishing up to three names per work, or stingy?

G. DIVISION OF THE ONLINE CATALOG INTO SEPARATE FILES OR INDEXES

Findings of previous user studies: One of the problems reported (#11, Appendix) is that users do not understand the differences between various files, indexes or fields. Forty-four out of forty-eight online catalogs described in Matthews [208] require users to specify an index in any search statement. For such specification to be optimum, the user must have knowledge of what is contained in the index being specified. The user may have to know the difference between a title and a subject, or a title and a corporate author, or a serial and a monograph. In many systems, the user must also specifically state whether he or she wants to search the authority file or the bibliographic records. This kind of specification is not a completely new

requirement, for divided card catalogs, closed catalogs, and book catalog supplements existed long before the computer, but the complexity of the specification required in some systems is new; and to some extent division of the catalog has always been regarded as something of an evil, necessary or otherwise. Most librarians are familiar with the battlecry "One place to look!" Some literature has begun to appear on the difficulties of searching names as subjects or uniform titles which are searchable only as part of the author index [243, 260, 264]. However, no direct user studies have yet been done.

Record design solutions: The tagging and coding in MARC records makes the division of online catalogs into files and indexes possible. The ability of knowledgeable catalog users to specify particular fields for searching is a very powerful tool for increasing precision, and, even though casual users may find it difficult to exercise the power, it would be a shame to lose the option for those who know enough about the MARC record to be able to use it.

System design solutions: Six systems that do not require the user to specify particular indexes or files are Paperchase, which does not require users to specify type of search unless too many records are retrieved, LIAS and Library Corporation's Intelligent Catalog, which present the user with a kind of dictionary file of all headings, MUMS, which defaults to a general index, if a specific index is not specified, and CLSI's PACII and LS2000, which allow the user to do a keyword search of a term index that contains terms from all indexed fields [8; 9; 22; 33; 108, p. 118; 113; 120; 148, p. 15, 35]. In all of these systems, the user always has the option of specifying a type of search if so desired.

Directions for research: We need research to determine whether the "dictionary" approach is preferable and/or feasible. How often are user errors and search failures due to index specification problems? How often would the "dictionary" approach contribute to the problem of too many items

retrieved? What kind of computer resources are required to support a default dictionary search?

If we continue with the separate index approach, user studies to determine what users consider to be a 'name,' an 'author,' a 'title,' and a 'subject' might be useful, as well as studies of users' searches, to see which fail because we have failed to put particular fields or subfields into the index the user chose to search.

III. CONCLUSION:

It can be seen that we have barely scratched the surface in researching online catalog users' needs so as to design more effective interfaces. Admittedly, this is a very difficult area in which to do research. Fidel and Soergel's lists of variables affecting online bibliographic retrieval provide a graphic illustration of one of the primary reasons such research is so difficult--the fact that there are so many variables [69]. Another reason is, of course, that that most elusive creature, the human being (in the guise of catalog user), is the primary target of our research.

This paper has concentrated on research findings that seem to have implications for record and system design in the online public access catalog. It must not be forgotten, however, that in dealing with a problem at the user-system interface, there are always two possibilities for its solution: change the system or change the user. In other words, if redesign of the records or of the software cannot solve the problem, it is always possible that user training is the answer.

Resolution VI adopted at the International Conference on Cataloguing Principles in Paris in 1961 was a recommendation that the implications of mechanization for cataloging codes be studied [123]. A quarter of a century later, we still do not have a very clear picture of the implications. Does automation require a fuller description, a la ISBD, which came in claiming to support the creation of internationally machine-readable records, and MARC, which calls for a great deal of redundancy, since many descriptive elements

are also stored in coded form; or does automation require a briefer description, so that more records can fit on a screen, and users can scan more records at a time? If it requires a briefer description, is it better to allow the computer to create it by arbitrarily lopping off particular fields across all records, or is it better to rewrite our cataloging codes to go back to more concise descriptions based on clearly defined objectives, such as those recommended by Lubetzky in the 1940's [158]?

Does automation encourage a new generation of perfectionist catalogers by requiring absolute accuracy [65, 89, 206], or does it allow us to dump in any old thing, and rely on the power of the computer at output time to find it all again [136, 137, 225]?

Does automation require accurate authority work to help users find all the works of an author, all editions of a work, and all works on a particular subject [171, 175, 206, 308]--does it in fact make it easier and cheaper for us to maintain consistent authority work than ever before--; or, with the search powers of the computer available to users, can we let the users do the work, as many commercial information retrieval services do [26; 136; 144; 164; 225; 232, p. 25; 273; 295]?

Should the code for the online catalog contain choice of entry rules to bring together all manifestations of a work, related works and works on the subject of a work (one function of the main entry), should it abandon the attempt to serve users in this way (e.g. abandon main entry for title unit entry, beginning each entry with the title on the item), or does the new technology require the development of new techniques for demonstrating relationships to our users, as the change from book to card catalogs did [17; 80; 83; 136; 144; 166; 203; 206; 218, p. 173; 273; 285; 308]?

Does automation offer an opportunity to expand our services by offering more analysis [117, 144, 203], better entry vocabularies for our subject access systems [7, 180], more access points [31; 34; 35; 40; 41; 96, p. 660; 170]? Or has automation already proven to be so much more expensive than expected that we must cut back on the amount of professional service we can afford to provide our users?

All of these questions should be answered based on research into user needs, and based on dialogue between the record designers and system designers who together create the user interfaces for our online public access catalogs.

FOOTNOTES:

1. Review display: main entry, partial title and date. Brief display: Main entry, title, edition and imprint. Long display: entire catalog record, including tracings. Browse display: headings and cross references from authority file.

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APPENDIX: USER PROBLEMS WITH ONLINE PUBLIC ACCESS CATALOGS:

The following user problems with OPAC's have been reported in the literature; they are not listed in any particular order:

1. Difficulty finding subject terms [71, p. 110; 126; 145, p. 111; 189, p. 33, 35, 43-44; 195, p. 66; 198, p. xxxii-xxxiii; 279, p. 20; 293, p. 145; 294, p. 124 (43% of users checked this on the CLR questionnaire, making it the second ranked of all problems); 299, p. 639]
2. Difficulty in increasing results [2, p. 12; 129, p. 40; 149, p. 102; 188, p. 150; 211, p. 96; 248; 294, p. 124 (46% of users checked this on the CLR questionnaire, making it the highest ranked of all problems. Note, however, that users had a lot of trouble with the system itself; see 15 below; those who had trouble entering commands properly may have checked this, too.)]
3. Overspecification--too many terms input in a single search [50; 57, p. 28; 71, p. 111; 86, p. 26 (13-18% of searchers used more than two keywords to search GEAC, and 48% of these retrieved 0 hits); 127, p. 9; 134, p. 33; 148, p. 42- (analyzes the number of searches using 1, 2, 3, etc. terms); 205, p. 31.
4. Key word search done when phrase search more efficient [50].
5. Failure to understand what the cause of error was; interpreting an error message to mean that the item sought is not in the library, when the problem has been an error in using the system [126, 134].
6. Difficulty in reducing results [2, p. 12; 86, p. 27 (37% of single keyword searches on GEAC resulted in 100 or more hits); 129, p. 40; 134, p. 32; 167, p. 112 (the average search on MELVYL retrieves 118 records); 188, p. 150; 205, p. 3; 173 (average retrieval on MELVYL 97-125 records per search); 238, p. 204; 240, p. 288 (17% of those who had changed from online catalog use to card catalog use switched because they had retrieved too many hits online); 294, p. 124 (in the CLR study 27% of users checked this problem, making it the 8th ranked)].
7. Use of nondistinctive words [50; 57, p. 28; 85 (users don't know the stoplist: 50% of assigned searches for a title with a common word not on the stoplist failed because the patron thought it was; 41% of assigned searches for a title with a word on the stoplist failed because the patron did not realize it was); 126 (stoplist problems); 274].

8. Difficulty scanning through long displays; includes problems caused by lack of knowledge of the filing rules used to display records when more than one record has been retrieved [126 (the lack of any filing rules resulted in all subjects failing to discover a sought journal); 176, p. 6; 198, p. xxxiii (one of the reasons classification searches were less successful than subject heading searches was that the displays were longer and the user was less likely to look at all of the display); 222; 294, p. 124 (In the CLR study 28% of users checked 'difficulty scanning through long displays', making it the 5th ranked problem; 12% checked 'the order in which items are displayed', making it the 23rd ranked problem; 11% checked 'understanding the display of multiple items,' making it the 24th ranked problem)].
9. Infrequent use, requiring relearning of the system [2].
10. Typo's, spelling errors, etc. [57 (54% of titles not found were due to user error); 127, p. 4, 8; 134; 140, p. 622 (10% of user input on OKAPI had spelling errors); 145, p. 111; 189, p. 38 (in a SULIRS transaction log study, 6% of subject search statements had spelling errors); 274 (6.4% of all searches failed because the user's citation was incomplete or incorrect); 279, p. 20; 286 (27.8% of no hit author searches failed due to this cause); 294, p. 124 (In the CLR study, 22% of users checked 'typing in exact spelling, initials and spaces,' making it the 10th ranked problem)]; 297, p. 82.
11. Users do not understand differences between various files, indexes or fields. They do not understand the difference between a controlled vocabulary search and a free text search. They do not recognize the difference between a corporate name and a title, or their citations do not give them enough information to discriminate. They do author-title searches in systems which do not allow them, or they fail to input author title searches as searches of two different indexes, where this is required [57; 85 (19% of failures were due to computer interaction failures on LCS: either the user had a problem with search key formulation, or the user accessed the wrong file); 126; 134; 189, p. 38 (20% of subject search statements were authors or titles, not subjects, in a transaction log study on SULIRS); 205; 274; 286 (9.8% of no hit author searches due to this problem)].
12. Fullness problems with abbreviations and initials [85 (40% of assigned searches for titles with abbreviations failed because the patron ignored the abbreviation, which the OPAC treated as a word); 286 (7.2% of no hit author searches due to these problems); 189, p. 43-44; 294, p. 124 (In the CLR study 22% of users checked 'typing in exact spelling, initials and spaces,' making it the 10th ranked problem; 17% checked 'using codes or abbreviations for searching,' making it the 15th ranked problem)].

13. In phrase searching systems, input of a different first word of a title or heading from that in the system; examples include input of articles, searching on author name with forename first, direct search of corporate name entered as a subdivision of a higher body, searching on a subtitle, and failure to enter the author's name as part of the title when it appears this way on the title page [57; 78, p. 231; 85 (40% of assigned searches for titles with author's name at the beginning of the title failed because the user failed to use the name as part of the title); 126; 222; 286].
14. Problems with spacing and hyphenated words [85 (67% of assigned searches for titles with hyphenated words failed); 126; 127, p. 6, 8; 198, p. xxxi; 222; 286 (2.2% of no hit author searches due to spacing problems); 294 (In the CLR study, 22% of users checked 'typing in exact spelling, initials and spaces,' making it the 10th ranked problem)].
15. Problems with the system itself. Users have trouble remembering the correct command names and correct command and search term entry procedures, as well as the appropriate times to enter particular commands. They have problems remembering where they are in the display process, and in remembering the rules for continuing or backing up the display process [50; 71, p. 109; 85 (19% of failures were due to computer interaction errors on LCS); 126; 127, p. 7; 129, p. 42; 134; 173, p. 18 (11% of commands on MELVYL are errors, and 59% of all errors consist of a user command which does not begin with a valid word); 222; 248, p. 60; 274 (11.9% of all searches failed because of errors in using LCS); 294, p. 124 (In the CLR study, 19% of users checked 'remembering the exact sequence of commands,' making it the 14th ranked problem; 20% checked 'remembering commands in the middle of a search,' and 'selecting from a list of choices,' making these the 12th and 13th ranked problems; 28% checked 'entering commands when I liked,' making this the 6th ranked problem)].
16. Difficulties due to lack of knowledge of the scope of the catalog, e.g. whether retrospective holdings are included, and the fact that most catalogs do not contain records for journal articles or single poems [71, p. 110; 126; 129, p. 43; 134; 145, p. 111; 149, p. 102; 211, p. 96; 222; 277 (34% of users had no idea of the scope and 9% guessed wrong); 279, p. 20; 294, p. 24 (In the CLR study 37% of users checked this problem, making it rank third)].
17. Failure to use available features which could help in a search, e.g. truncation [86, p. 26 (only 6-10% of users use boolean operators or truncation); 134; 145, p. 111, and 279, p. 19 (the keyword search is not being used extensively); 148, p. 42- (reports on transaction log monitored data on the percentages of searches which use more than one term, the percentages which use Boolean logic, and the percentages using truncation)].

18. Difficulty understanding codes and abbreviations in displays, especially location and circulation information [126 (inability to recognize call number); 186, p. 164; 294, p. 124 (In the CLR study 17% checked this, making it the 16th ranked problem; 14% checked 'locating the call number on the screen,' making this the 20th ranked problem)].
19. Difficulty due to brief displays [240, p. 288 (17% of the users who switched from the online catalog to the card catalog did so because they desired a fuller record)].
20. Difficulty understanding HELP screens and messages, including difficulty understanding see references [126; 188, p. 133; 294, p. 124 (In the CLR study 21% checked this, making it the 11th ranked problem)].
21. Difficulties with Boolean logic [13; 205].