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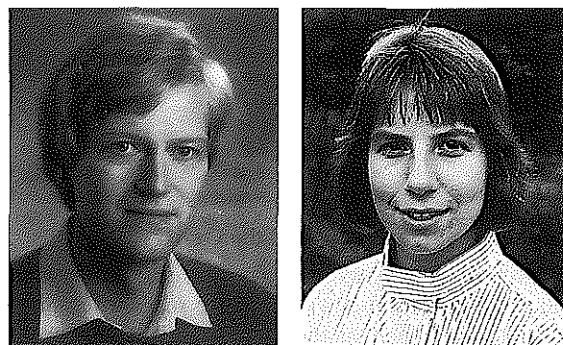# The Design of Subject Access Elements in Online Public Access Catalogs

Experiences with retrieval in OPACs suggest that there are major problems for the users of such systems, such as choosing the 'correct' subject access vocabulary, narrowing or broadening the set of items retrieved regarding the search interest. Such problems relate to two facts: (1) that in the early OPACs subject access has not been considered seriously enough and (2) that the complexity of the topic has not been really recognized. Using a typology of users' questions it is demonstrated which requirements musts be met by a successful online subject access. Improvements of subject access tools are primarily aimed at, pinpointing the interplay between the different subcomponents of any subject facility: a) the features of the indexing languages used; b) the indexing principles used; c) the design and structuring of the database; and d) the possibilities of the technical retrieval facility, the search mode, and query languages. The contribution summarizes the manifold interactions between the four subcomponents listed. Any successful retrieval will heavily depend on the design of these components considering their interactions.
(Authors)

1. Problems in Using

In the first development stages of Online Public Access Catalogs the subject access element of this new medium was generally neglected, assuming as one did that this novel catalog form, like the traditional catalogs, would be mainly used as a finding tool for known items.

However, user studies on Online Public Access Catalogs idFicated a shift in user behavior in that far more subject searches were being carried out than had been anticipated. In the USA, numerous user studies have been carried out on OPACs (1-9 and 72) which revealed a proportion of subject searches of an average 51 % (10).

Noteworthy in this connection is the fact that this increase in subject searches has not gone hand in hand with a corresponding increase in success in retrieval (9, p.153). While in his search in the online catalog the user is far more perseverant[1] than in the traditional catalog, he is not in the same measure more successful (9, p.151). A query among OPAC users revealed that 85% of those questioned are content with their searches. But an analysis of the query results reveals likewise that 56% find nothing or only a part of what they are looking for. This result should, however, be viewed skeptically, as online catalog users cannot estimate how much information they have failed to find.

As user problems in subject searches the following categories have crystallized out[2]:

a) *Difficulties in selecting the correct search terms*

The user has difficulties in squaring his search subject with the OPAC's indexing vocabulary. The vocabulary admitted for searches is regarded as too small, the predictability and/or fidelity (12) of the terms to be used is insufficient. Lacking information on the vocabulary to be used and lacking conceptual links within the vocabulary frequently make the users select too special or too general search terms. These statements apply both to the use of verbal documentation languages and to that of classification systems, for which the verbal class designations frequently are not inverted along.

b) *Difficulties of increasing the hit rates*

A large number of searches ends with the user obtaining no or only a too small quantity of hits. The proportion of searches that end in failure lies between 35% and 57.5%. It may be assumed that the actual proportion is even higher, as the number of hits does not guarantee that the user has in fact found relevant information. A major part of the searches that have failed is due to the user's unawareness that he must put in a search term from a controlled vocabulary. Lack of knowledge about the indexing vocabulary thus frequently makes for very low hit rates.

c) *Difficulties of reducing the hit rates*

It also occurs very frequently that the user obtains very high hit rates. Unaware as he is of existing limitation possibilities, he may have to leaf in these cases through more than 100 titles turned up (10, p.84).

It is particularly these two latter points which need to be paid increased attention. In the initial stage one is inclined, when using an OPAC, to rejoice over every hit which the qualitatively improved search possibilities, compared with the time-honored ones in traditional catalogs, enable one to achieve. However, as document stocks grow and familiarity with the system increases, one will feel an increasing desire for precise results with re-

speet to the query and will note that the avoidance of noise constitutes the major problem. For meeting the aforementioned requirements, an optimized subject access element should provide tools which, in their results, neither increase noise nor entail information losses.

2. Developments in Subject Access Elements Design

The difficulties experienced by OPAC users may in part be explained by the significance - or the lack of it - attributed to the subject access elements in the first development stages of this medium. Therefore we wish to present here a brief overview of the OPAC's development history. C.HILDRETH subdivides the existing Online Public Access Catalogs into three generations (13).

Most online catalogs of the first generation have come forth from libraries' lending administration or cataloguing systems onto which a so-called user interface was superimposed. The catalogs of this generation permit only precombined searches, as they are customary in card catalogs. These Online Public Access Catalogs were mainly conceived for known item, at most title keyword searches. In connection with the systems from which they came forth there are hardly any subject description data available. The dialogs are either strictly menu-controlled or based on a command language.

It was only in catalogs of the second generation that subject searches via keywords and subject headings became possible. At the same time these online catalogs have a sophisticated retrieval language at their disposal which uses, among other things, Boolean operators. Further aids in searching are browsing in the index and the possibility of systematic searching for call numbers or notations. Second-generation OPACs have a more flexibly designed user interface, with a shift from menu to command mode and vice versa frequently being possible.

This differentiation between inexperienced and experienced users should be overcome in the OPACs of the third generation. In these systems the user interface is more adapted to the users' needs (e.g. input of questions in natural language). At the same time these catalogs present improved possibilities for subject searching. Free-text and controlled vocabularies are mutually inter-linked and further subject access possibilities are integrated into the data records. These systems also have correction algorithms at their disposal which try e.g. to correct any textual errors or to perform an evaluation of the retrieval results. Online Public Access Catalogs of this generation are directly developed systems rather than having been fitted retroactively to a cataloguing or lending system.

3. Subject Access Elements

Before discussing the various parts of the subject access elements it needs to be clarified just what is meant by the subject access element and what requirements can be imposed on it.

The subject access element is a highly complex entity having several components. Carol A.MANDEL describes it as a three-dimensional puzzle in which four mutually independent factors meet (14):
a) The design of the user interface;

b) the data records that become accessible through the Online Public Access Catalog;
c) the users utilizing the Online Public Access Catalog for their search questions;
d) program routines for facilitating such search questions.

If an online public access catalog is to offer possibilities for subject searching it is necessary to take all these factors into consideration in the planning and to balance them among one another.

With respect to the data records it must be clarified for subject searching purposes what vocabulary will be made available for retrieval. This question concerns both the indexing method (extraction or addition method)[3] and the indexing principle (co-ordinate or syntactic indexing)[4].

The retrieval language must permit the user to have effective access to the indexing vocabulary. To solve this problem one may have recourse to experience gathered with retrieval systems in literature data bases. However, in comparison with literature data bases an Online Public Access Catalog has relatively little indexing vocabulary at its disposal (e.g. no abstracts).

In addition, the documents contained in the online public access catalog are highly multidisciplinary. Thus, in retrieval in the online catalog more attention needs to be paid to vocabulary selection and design and control.

The complexity of the subject is increased by the fact that special requirements are imposed on the user interface of an online catalog. Library patrons are not trained information searchers, and the user interface must be so designed that subject searches can be performed even by inexperienced users. Therefore, in connection with the user interface, consideration must be given to whether and how it can assist the user in his subject searching, but also to when it limits subject searching possibilities.

In addition, thought must be given to whether program routines can be made use of for assisting in subject searching. As the final important factor, the layout, too, plays a part. The user should be able to recognize from the display of the subject information whether the document is of interest to him. The subject information must therefore be clearly formulated and plainly put in relief.

4. Typology of User Questions

To be able to lay down what a subject access element should contain, we will attempt to determine on the basis of a typology of user questions what different requirements occur. On the user's actual subject information needs only little is known. The enquiries observed in the analysis of transaction logs cannot be made use of in this form, for it must be assumed that the users tailor the formulation of their questions to the search possibilities available. From such a typology conclusions should be drawn as to the design of and the possibilities to be offered by the retrieval components.

a) *Questions enquiring after simple subjects (lexicon questions)*

Such questions can - as a rule - be represented by a word or by annotation of the indexing language used in

the system, i.e. by the semantic component. For answering such questions, therefore, the availability of the vocabulary together with its relational structures would be sufficient. However, as an actual user's need (rather than as a query actually observable so far) such questions are far rarer than usually assumed (10, p.62).

b) *Questions relating simple subjects to formal data (author, publisher, year of publication, etc.)*

This is realized by pre-set or free linkages (possibly using Boolean operators) of the categories concerned. Although a typical characteristic of online catalogs, this is not originally a problem of subject access element design.

c)*Questions relating simple subjects to data pertaining to time and/or space*

This type of questions might well occur quite frequently: at least in the free combinability of the various aspects, it surpasses the possibilities of any conventional catalog. Realization requires the availability of corresponding indexed items (subject headings, notations, etc.) as well as a retrieval component permitting the combination of these items. Such combining can take place through the linkage of corresponding index categories or through the free application of Boolean operators equipped in a wide variety of ways, not excluding the complex bracket logic as we know it from the commercial retrieval languages.

A voluntary foregoing of such search possibilities in an online catalog could hardly be said to measure up fully to the expectations that will be placed in these systems, at least in the more progressive ones among them.

d)*Questions giving expression to complex, a posteriori relations (including directional relations resulting e.g. from actions)*

It is probably this type of question which gives rise to the majority of controversies as to the necessity of realization in library catalogs. Reasons for giving this type of questions a certain amount of attention are presented by the fact that this type is anything but rare, while on the other hand - particularly in multidisciplinary and growing document stocks - the answers to these questions are particularly unsatisfactory if the proper searching tools are not available. Not in the last place, approaches toward a solution of this problem can already be found in the great majority of indexing languages - even if usually only (which admittedly is a serious setback to post-coordination in online catalogs) in firmly joined precombinations in the vocabulary, which thus are not available for free combinability (15).

Realization requires in any event the use of Boolean operators. For directional relations, syntactic aids must be made available which, through suitable representations, must also become visible on the surface of the indexing language. Whether these syntactic aids are also to be used directly for retrieval purposes is a question requiring deeper consideration.

e) *Questions in the nature of cases c) or d) above that are related to or circumscribed by means of formal data*

As already indicated before, this case is particularly frequently mentioned in the user observations as most systems so far do not have sufficient possibilities at their disposal for a suitable reaction. In future design, this point should, above all, be given special attention. As we will see later, this is also the point where one should not confine oneself to using only a single type of indexing language, but rather honor the long-proven experience that a combination of several description methods (verbal and classificatory) promises the best results.

5. Possible Components of the Subject Access Element

5.1 Indexing Language

The first subcomponent to be considered is the indexing language used. Already on this level there is a great diversity. As a first differentiation, the traditional division into classification systems and verbal indexing languages is useful: for further-going considerations a finer differentiation is required.

Because of their versatile possibilities of use in indexing and retrieval in online public access catalogs, classification systems are once again being paid increasing attention[5]. As numerous contributions have already pointed out the usefulness of classification systems in online retrieval, suffice it here to recapitulate only their chief advantages. In online retrieval, classification systems can in a variety of ways be successfully applied to reduce the noise rate in retrieval and to improve the precision of the results. The following possibilities of use exist:

In the first place the possibility of narrowing or expanding concept fields. This possibility is only offered, however, by classification systems with expressive (structure reproducing) notation systems[6]. Thus, such classification systems also help to narrow or expand hit rates. Furthermore the use of classification systems provides a possibility to place verbal expressions into a conceptual framework and thus to avoid ambiguities. Particularly in multidisciplinary data bases verbal search terms may be ambiguous. By linking the search term with a class from the classification system conceptual unambiguity may be realized (22). With the aid of classification systems it is also possible to specifically exclude classes of subjects from the search. Moreover, working with a classification system facilitates searches for thematic subjects that can only be formulated with difficulty by verbal search terms (23). If it is displayed in what contexts the unconcrete words occur in the classification system the user can specify his question further.

The use of a classification system also permits the display, during a search, of systematically ordered title lists furnishing a better overview in the case of large hit rates.

Of interest, finally, is the question whether access to the classes is possible only through input of the notations or via the class designations. If maximum comfort of use is striven for, only the latter possibility would probably be acceptable. But to what extent a verbal access may be an alternative to a verbal access component is a question that is not easy to answer and depends in large measure on the details of concretization. The mere inverting of class designations assuredly will not produce a vocabulary suited to serve as a verbal access possibility. The

class designations would at the very least have to be processed for serving as a retrieval tool. Measures for terminology control would have to be taken, descriptors for individual concepts be admitted and the vocabulary be enriched by further search terms (18). Nevertheless, class designations are increasingly regarded as a good alternative to verbal indexing languages[7]. Regardless of how the verbal access vocabulary is designed, a linkage with the notation system should be guaranteed in any event.

Verbal indexing languages constitute, at first glance, the more homogeneous world when compared with classification systems. But at the very least one should determine whether one wants to work with individual subject headings, with thesaurus descriptors or with precombined subject heading strings, whether and to what extent one wishes to engage in terminology control and, if so, how the vocabulary is to be attended to in so doing. Here it is imperative that it should be recorded, and be kept available at all times in a suitable instrument, what vocabulary has already been used - all this without overlooking the fact that not every type of vocabulary is suited for every type of retrieval. This depends in large measure on the indexing principle. The limits of the possibility of retrieval by verbal means are reached at the latest when hit rates need to be increased or decreased. On the vocabulary level it is not sufficiently possible to carry out concept limitations or expansions. For practical use, a floating transition from a verbal indexing language to a classification system would be particularly helpful. The user could then start his search on the verbal level and for concretizing his question change over to the classification system level.

5.2 Indexing principle used

At this point it is necessary to give attention to the indexing principle, independently of the indexing language. Because of the technical possibilities of postcoordination through Boolean operators, access is frequently had in the OPAC to all data available, regardless of whether they are suited to such access or not. This can be explained by the wish not to forego under any circumstances the possibility of postcoordinatingly relating search terms to one another. This, however, will by no means necessarily improve retrieval results in every single case; on the contrary, precombinations strikingly and extensively present in the vocabulary - in particular hidden syntactic interrelationships in composites - may quite negatively affect the predictability and fidelity of the indexing vocabulary used[8].

Coordinate and syntactic indexing will at this point be briefly introduced and be examined as to their application possibilities in retrieval.

a) *Coordinate indexing*

In coordinate indexing the descriptors are lined up alongside each other irrespective of any relational viewpoints whatsoever. This indexing principle was developed mainly for postcoordinate retrieval. A major problem in this connection is the question to what extent complex concepts should be broken up. Should a complex concept consisting of several individual concepts be represented by a single descriptor (precombination), or should it be separated into its parts and be represented by several descriptors in indexing (postcoordination)? Both procedures have their own advantages and setbacks[9], so that in selecting the descriptors a middle path should be chosen. Thus the German standard DIN 31623 Part 2 (28), for example, presents procedures for concept disassembly and for concept assembly. It should be noted here that the designations are not broken up into their morphological components. Since the a priori relations must be reproduced in the vocabulary, a semantic resolution of concepts should be performed.

In the retrieval of complex subject headings, coordinated indexed items frequently entail disadvantages. Linkage of individual subject hadings, which always represent individual concepts exclusively, is to permit, in postcoordination, the reproduction of complex topics, which as a rule can only be imperfectly achieved through such linkage using Boolean operators (see ch.5.4). Coordinated indexed items are only insufficiently suited to represent complex subjects.

b) *Syntactic indexing*

Through syntactic indexing, more precise results are to be achieved in retrieval and noise thus to be avoided. Presence of syntax and/or use of syntactic aids is distinguished on three levels:

A: The level of the indexing language vocabulary available for indexing (precombined syntax).

B: The level of the indexed items or that of the indexer's as user of an indexing language, i.e.: can the indexer synthesize complex propositions from components of the vocabulary using syntactic aids?

C: The level of the user of a documentation language, i.e.: can the user address to the documentation system, in synthesized fashion, complex questions made up of components of the vocabulary, using syntactic aids?

To represent a posteriori relations on the vocabulary level, precombined descriptors must be formed, a procedure we will call 'precombined syntax'. Now, while these precombinations have a high degree of precision, the resulting volume of the vocabulary renders the predictability of the descriptors more difficult. Also, precombined concept links render links on levels B and C problematical. On the vocabulary level, therefore, it is first and foremost the semantic (a priori) relations which should be uncovered.

While the semantic concept links are recorded in the vocabulary, the expression of syntactic a posteriori relations on the indexer level requires the availability of suitable tools. To this end, various possibilities suggest themselves (29, 30). The use of prepositions between the subject headings and the formation of descriptor strings as well as the formation of subsets (using links) and suitable weighting indicate that a relationship exists among the descriptors. A directional relation can, however, only be made explicitly clear through the assignment of role operators.

If, for postcoordination purposes, one wishes to use components of precombined indexed items or of indexed

items structured according to the syntactic indexing principle, problems arise that need to be solved (see 15):

a) Are the rules leading to the formation of the precombined expressions of such a nature that the individual components have expressive force with a view to post-coordinate searches? In other words, do the various components have a complete semantic identity or does their complete understanding rather require a semantic information transfer from other parts of the complex of precombined or syntactic indexed items?

b) How are the precombined or syntactic indexed items to be processed to make them suitable for postcoordinate searches? In other words, what measures does one take for keeping intact or restoring necessary semantic units? A search through the totality of the precombined indexed items would certainly be an imposition on the user; in that case the OPAC would limit the search even more than a card catalog[10]. If one breaks up the precombined structures into individual descriptors one will face the same retrieval problems as in the retrieval of individual descriptors (see 5.4 below), and the efforts invested in the formation of the precombined structure are lost. A practicable solution seems to be the approach used e.g. by the British Library in its searches for PRECIS strings: After the input of one or two search words *all strings* are displayed in which the search words occur. Thus the user can draw conclusions from the precombinations displayed as to the contents of the documents and will obtain more precise retrieval results (32), see also Gödert in (15).

c) How are the implicit or explicit syntactic aids, if any, made utilizable for retrieval purposes?

Answering these questions probably constitutes the most difficult problem to be solved in the design of subject access elements of online catalogs. In considering the indexing principle it undoubtely remains valid that syntactic indexing cannot be foregone if effective searches for complex subjects are to be rendered possible.

5.3 Search field access design

The data of any bibliographic item are stored by fields. In processing them for search purposes it must be decided whether specific access to individual fields is possible or whether several fields should be combined into one search field.

Access to individual fields requires the user performing the search to have exact knowledge of the structure of the data record. This approach also permits, however, precise access to the controlled vocabulary.

Retrieval tests concerning recall rates have shown, however, that searches using controlled vocabularies exclusively do not produce the best retrieval results (33) (73). Such searches must, therefore, either be substantially improved or be supplemented by searches using other elements. As such, free-text elements have usually been employed so far (34).

In many systems, specific access to individual fields is replaced by the formation of a basic index[11] in which free-text and controlled vocabularies are offered jointly. Since data inhomogeneity causes a search using free-text

vocabulary to always produce noise as well[12], this method will likewise result in an increase of the noice rate. The subject search should therefore be performed first of all in the controlled vocabulary, whose processing and/or indexing for retrieval purposes should be improved. The use of natural language for free-text searches recommends itself, on the other hand, for searches for individual concepts and highly new terms[13]. In the related indexing one should not forget to provide, besides access to the individual concept, also the possibility of access to an abstract superordinated concept. Only in that way can the completeness of the subject search be guaranteed.

In addition to the fields for the indexed items one may provide further fields for formal criteria, such as e.g. for the form or language of publication (38). These criteria can be combined with the search concepts and thus provide further possibilities for limiting the search.

5.4 Retrieval language

The retrieval language on which one whishes to base the Online Public Access Catalog must be selected in accordance with the indexing principle. This is particularly important if the documentation system features syntactic indexing. The retrieval software must permit the user to ask the documentation system complex questions consisting of components of the vocabulary while using syntactic aids. But in the case of coordinate indexing, too, aids must be offered to iron out the setbacks resulting from the indexing principle.

a) *Boolean operators*

The Boolean operators AND, OR. NOT are among the most important components of the retrieval language. They are indispensable for performing postcoordinated searches, in which individual descriptors are to be related to each other by linkage (39, p.532). Now while Boolean operators are a powerful retrieval instrument, their use is not wholly without problems, for it also frequently results in less than precise searching results. Some of these setbacks will now be briefly presented here.

Searches with the aid of Boolean operators will also turn up titles that are more specific than the search query as originally formulated. With the use of Boolean operators only it is not possible to search exclusively for the search words desired. Documents indexed with more descriptors than only the search words put in will likewise be reported as hits.

Example: A search for "woman AND age" could also turn up, as hits, the following titles (e.g., indexed with the following RSWK strings (RSWK = Rules for Subject Cataloguing))

> Woman / age / personal report
> Woman / age / fitness / guide
> Woman / age/ living conditions / Germany
> Woman / age / mental hospital / narrative interview

Furthermore there is no guarantee that in the hits turned up the descriptors as put in occur in a conceptual

contest. They may also occur in the document wholly independent of each other if two or more strings are assigned to the document.

Example: The title: "Gervasi, Tom: Moscow's Supremacy" was assigned the following descriptors:

USA / Arms race / Soviet Union

USA / Strategic defense initiative

This title also turned up, however, in a search for:

Soviet Union AND Strategic defense initiative

Finally, it is not possible to express directional a posteriori relations by means of Boolean operators.

Example: A search for "Evaluation of students by teachers" would be expressed by Boolean operators as: evaluation AND students AND teachers.

Titles such as "Evaluation of teachers by students" would then also turn up as retrieval results.

Particularly when employing syntactic indexing this would lead to unsatisfactory retrieval results (13). These problems occur to an increased extent if one is searching in a "basic index".

Besides for searching within a search category, Boolean operators may also be used for linking up various categories among one another. To this end it is necessary to put in, besides the search terms, also the relevant category designations (38, p.438). For subject searches this possibility is of interest if, e.g., subjects are to be limited by formal criteria.

The use of Boolean operators in Online Public Access Catalogs is not uncontroversial. It is feared that the user may fail to grasp the logic behind these operators, resulting in their incorrect use (40). Yet it is not possible to dispense with these powerful linkage possibilities. Their use is necessary for handling complex search queries in the online catalog.

Some of the problems occurring in searches with Boolean operators can be avoided by using syntactic aids, such as coupling indicators, on the indexer level (41).

b) *Adjacency and context operators*

To alleviate the shortcomings occurring in searches using Boolean operators, the user may be offered syntactic aids. By means of adjacency or context operators it may be indicated in what order, how closely together or in what data record the words sought are to occur, it being assumed in this connection that a relation might exist between these descriptors if they occur closely together (42, 43).

Adjacency operators may furthermore be used in searches in controlled vocabularies for laying down the order of the descriptors or for expressing the distance that is permitted to occur between the descriptors in a string.

c) *Masking (Truncation)*

For searches in the free-text vocabulary the retrieval language must permit masking to that morphologically related words may be searched for. In the case of right truncation, all words are searched for which begin with

the character sequence put in. Frequently this leads, however, to numerous undesirable words, as the given conceptual realm is abandoned. One can try to mitigate this problem by employing limited masking, consisting in laying down the number of characters to follow the character sequence put in (42, p.120-122).

In addition to right truncation, left truncation would also be desirable, permitting as it does the finding of compound words of which the word put in forms the second component. As compound words occur frequently, particularly in the German language, this element of the retrieval language would be a useful instrument (44).

A final masking possibility would be masking the center of the word. This could be used in the case of deviating spelling or if the user is not sure of the correct spelling of the word.

d) *Menu guidance*

For the user to be able to employ the aforementioned retrieval possibilities for conducting effective searches, he must have exact knowledge of their use and their effectiveness. But as it cannot be assumed that all users are able or willing to go into these retrieval intricacies, the online catalog should also put simplified retrieval possibilities at their disposal.

For this purpose a user interface is created in which suitable presettings are performed which lay down search categories and perform automatic linkages as well as, possibly, automatic maskings.

Through menu guidance and 'suggestive prompts'[14] the user is enabled to ask the system more complex questions. Though flexibility is reduced, the inexperienced user still obtains satisfactory retrieval results.

e) *Numeric area queries*

A further important property of the retrieval language is the scanning of numeric areas. In this way the user can be enabled to set limits to his search questions by means of numeric criteria (.e.g. publication year). The search for numeric data constitutes a special problem. It includes e.g. in our aforementioned typology of user enquiry the setting of time limits. If, in addition to and beyond a search for individual years, one also wishes to query according to time intervals, it is necessary that these data be stored in specific numeric data fields so that access to them may be had using numeric relational operators (e.g.). This is not in the last place a question of databank structure; and the existence of such data is a question of the indexing language and the indexing conventions agreed upon.

5.5 Search for indexed items

Here it is necessary to distinguish between 'direct searching' and 'browsing'. No OPAC should be allowed to offer just one of these two searching possibilities exclusively. Both procedures have their advantages and setbacks. It should be possible to select between the two as suggested by the nature and complexity of the query and according to the user's knowledge level (46).

a) *Direct searching*

A retrieval process is termed a 'direct search' if hits are reported immediately upon the input of the search term(s). This approach thus leads directly to a title display without any 'detouring' through any indexes. Compared with browsing, direct searching is much faster. However, it is not very error-tolerant. Search terms must be put in in the correct order, i.e. according to the syntax of the retrieval language, and in the correct spelling. In searching for the correct search term, a direct search would be the simplest solution, but for the user the most unsatisfactory one. After having put in a search term, the user is informed in reply whether this term is stored in the catalog memory or not. In the latter case he must put in a new word. The direct approach is useful only if the term put in matches a descriptor or is marked as the synonym of a descriptor. If the word put in is not a descriptor, attention should be called to the preferred term (45, p.121). A linkage from the non-descriptor to the descriptor should not take place without the user being so informed. The user would only be needlessly confused if the retrieval result displayed uses a different term from the one he has put in. Hence the system should call attention to the preferred term and, after confirmation by the user, continue the search with the descriptor. A renewed input by the user should not be necessary. Direct searching becomes problematical if the search produces no results although the user has made only a syntax mistake. These errors may be straightened out in part by improvement algorithms.

b) *Browsing*

The search process is called browsing if title displays are preceded by a search in the index. This search can, varying with the search process, be conducted in variously ordered descriptor lists or in abbreviated-title displays. In these indexes the user can also look at preceding or subsequent entries. 'Browsing' thus describes a search process taking place in like manner as a search in a card catalog (48).

Browsing through the search vocabulary is generally found useful by users trying to select the proper search term (49). This can undoubtedly be explained by the fact that browsing in the OPAC is patterned after browsing in the traditional catalog.

Browsing is slower than a direct search. The user must start by putting in a search word and then - after having browsed through the index - again select a search word. On the other hand, this browsing furnishes him an overview of the indexing vocabulary, which can then be of assistance to him in further searches (46, p.64).

For browsing in the descriptor lists the user puts in a search word. This term is either complete or is masked (truncated) by him[15]. In some systems the search word is masked also implicitly, in which case the system guides the user to a specific point in the index from which he should be able to browse both forward and backward.

If long lists are displayed, browsing proves to be problematical, as the user easily loses patience and merely skims over the contents of the screen. In these cases hierarchically graded lists as introduced by M.MASSICOTTE are recommendable (51).

That such a procedure may be important is indicated also by a behavior study which showed that the user immediately stops reading the list when he has found a relevant word, even if further relevant words are contained in subsequent parts of the display (52, 53).

The indexed items can be arranged either alphabetically or systematically. Alphabetic descriptor lists should indicate synonyms and inform the user of the preferred term through appropriate cross-references.

In an expanded form they can also indicate hierarchical relations (super and subordinate concepts) as well as associative relations. The user's attention can be called to these relations during his search by socalled 'action codes', which make it easier for him to handle the vocabulary lists and which help him in his search (54). In the case of subject heading strings, Keyword-in-Context or Keyword-out-of-Context lists should be made available to permit access to subheadings as well (4, p.50-51).

Alphabetic lists furnish a rapid overview of the vocabulary and help in the correct formulation of the search word (53), thus being able to provide effective help in searches for simple subjects. They have the disadvantage, however, that they can only illuminate relations between subject terms resulting from the alphabetic sequence.

Systematic descriptor lists are particularly useful for determining the hierarchical conceptual level of the word sought, as well as for correction purposes if the subject search produced unsatisfactory results.

For the representation of hierarchical conceptual structures several models are available:
- The hierarchical conceptual relations between the subject headings are displayed in the form of search trees which, in thesaurus-like manner, indicate the super- and subordinate concepts (54).
- Through the input of a notation, browsing through the class designations of the classification system becomes possible (20).

Likewise available is the possibility to systematically search for documents. 'Shelf-list browsing' simulates a systematic search at the shelf. The user puts in a call number, upon which a systematically orderd title list is displayed. Such a search presupposes, however, that the call number is known to the user.

5.6 Display of indexed items of documents found

The display of the indexed items in the data record of the documents found can likewise be offered as an aid in subject searches.

Having found relevant information, the user has the data record displayed. In reading the data record the user estimates the subject relevance of the title. If the indexed items are displayed, too, he may obtain the helpful information under what descriptors or notations he may obtain even more information (10, p.115).

Display design varies widely[16]. To facilitate the search for further subject information the aforementioned data may be put in relief, e.g. by doubling their luminosity (10, p.115).

In displaying notations the class designation should in any event be displayed alongside so as to facilitate the user's understanding.

5.7 User interface

The user interface constitutes the connecting link between man and machine. Particularly because of the differences between user groups, user interface design is a difficult undertaking, since every library patron should be able to use the online catalog without being familiar with it in detail.

Varying with their mentality, their familiarity with the system and their experience, users will impose different requirements on the online catalog. While the inexperienced user will let menus guide him through his search, the more advanced user can ask questions of greater complexity. The user interface should therefore offer various levels of difficulty so as to satisfy the different needs. A change-over at any desired stage should be possible[17].

One should beware of letting the inexperienced user's needs be the decisive factor in user interface development. The users must also be given the possibility of self-development in their searches. Systems designed exclusively for user-friendliness usually offer only a limited measure of retrieval convenience[18].

Of great assistance in retrieval are the 'help' functions, especially the 'suggestive prompts' which at various points in the search make suggestions to the user on how to continue his search. So that they may be properly understood and utilized by the users, these help functions should be very carefully formulated (52).

5.8 Proposals for improvement

The user studies mentioned in the beginning have given rise to various proposals for improvements, with one school of thought trying to improve retrieval by statistical and technical means, while another one advocates measures for improving the vocabulary used in indexing, the indexing principle applied, and database structure.

a) *Improvement algorithms*

Improvement algorithms are internal computer programs to be used when a search has produced no results. Since many negative retrieval results are caused by misspelling of the search word, one can try to make up for this error by spelling correction programs (58). The usefulness of this technique is limited, however.

More sophisticated algorithms look for words whose pronunciation sounds much the same as the search word. The Soundex algorithm is an example (59).

In the next step one can try to form morphologically related words. These procedures include the automatic masking of the search terms and the reduction of the word to its stem, the so-called 'stemming' (60). It is assumed here that a morphological relationship also implies a semantic relationship, e.i. that the newly acquired search terms will be related contents-wise to the search term put in.

Other algorithms are used in efforts to expand the given semantic area. They try to find similar concepts to the search concept. These techniques include the closest match search and the fuzzy-set approach (35), (61).

In addition, programs have been developed which perform an evaluation of the search vocabulary ('ranking') (62). In so-called 'user feedback routines' (10, p.117) the users can rank the importance of the various search terms, upon which the computer recalculates the relevance of the various documents.

The Harper algorithm in the OKAPI system works in much the same way (63). If, in OKAPI, several search terms are put in, they are first linked together by an implicit AND. If the search yields no hits, the socalled HYPER-OR is put in which is to determine those documents which can roughly satisfy the query. The selection of these approximate hits is based on Harper's algorithm, whose basic idea is that the search terms grow in importance as they become more specific. The less frequently a search term occurs in the database, the more important it will be. In selecting the titles, those ones will be considered first which contain as many as possible of the rare words.

Since all these methods influence ony the recall but not the precision of the result they cannot be regarded as a solution to all problems brought to light by the questioning of users.

b) *Expansion of the search vocabulary*

From various quarters it has been suggested to enrich the data records by information from tables of contents and indexes. In that way the user would have more vocabulary at his disposal for keyword searching, which would increase the probabilitry of hits (64). In large data quantities this procedure will undoubtely create problems resulting from lacking terminology control (65).

Similar problems are to be expected if the various data records of a catalog are filled with data from various subject description systems a trend which seems to be present in West Germany (66-68). Through taking over data from extraneous sources, this procedure can be realized in a relatively fast and easy manner. The number of terms characterizing the contents of the document will in this way indeed increase, but because of the inhomogeneity of the data noise-free retrieval will not be possible (69). Thus it does not appear to make much sense to stimulate the search for free-text elements by clogging these fields with data.

c) *Entry vocabulary*

A helpful tool in subject access would be the formation of an entry vocabulary as proposed by M.BATES. The aforementioned user studies show that users have difficulty in finding the correct search term. M.Bates explains this phenomenon with the versatility of natural language. As complete indexing consistency cannot be achieved in any indexing system, the user should not be expected to always correctly determine the descriptor (54, p.361). In addition there is the problem that users preferably use their own search words in their searches without obtaining information on the controlled vocabulary (10, p.70).

One solution to this problem would be the development of two vocabularies: one used by the indexer and one placed at the user's disposal. This 'end user thesaurus' would then serve as entry vocabulary. It would contain numerous terms from the natural language and thus be far more voluminous than the controlled vocabu-

lary. Thus the user might formulate his search term in the natural language without acquainting himself prior to his search with the controlled vocabulary. Besides conceptual quasi-synonyms this vocabulary would also cover alternative spellings.

The terms of the entry vocabulary would be connected with the controlled vocabulary by cross-references. Upon input of a search term, the controlled vocabulary would guide the user to the computer's internal cross-reference network (34), (54).

An 'end user thesaurus' of this nature would undoubtely be an effective tool, but also a laborious one, for it needs continuous vocabulary control and updating. Entry vocabularies need to be drawn up by each library individually so that no blind cross references will occur. The user should only be guided to such descriptors as correspond to available literature. In addition, such an entry vocabulary needs to be continuously expanded and updated: The compilation of a further file comprising all those designations which did not lead to a descriptor would permit a continuous expansion of the entry vocabulary (19).

6. A summing-up

Now what conclusions follow from the above? Here we will summarize a few criteria which in the authors' opinion add up to a good subject access element.

For subject searches in the OPAC the document must be assigned subject description data, as the free-text elements available in the data record are suitable only to a limited extent for retrieval purposes. They should be supplemented both by verbal and classificatory retrieval elements.

The controlled vocabulary must indicate the occurring conceptual relations. These include cross-references to super- and subordinate concepts as well as to selected associative concepts. In addition to the controlled vocabulary. Further contents-characterizing data such as form headings, time indications, etc., which through linkages with the vocabulary permit concretization of the search question, should be stored in separate fields. To permit searching for complex subjects the controlled vocabulary is based on the syntactic indexing principle.

Besides a verbal documentation language a classification system with structure-reproducing notation is also available. This classification system features verbal access, i.e. transition from the verbal indexing language is possible. The classification system is an important tool for improving the completeness and precision of recall. The combination of verbal and classificatory search elements is to offer the user a measure of searching convenience which leads to satisfactory retrieval results. The noise rate is to be as low as possible. It is only if no results are obtained on this basis that one should start searching in the free-text vocabulary. Improvement algorithms, too, should only be put to use if previous methods have failed.

The retrieval language must, in addition to Boolean operators, also permit the use of syntactic aids as well as numeric area scanning. The retrieval process takes place as a rule via the display of the indexed items. In that way

the user can correct his search question if the search term selected by him turns up too many or too few documents. Also, he can assess the relevance of the indexed documents already in the search state without first having the titles displayed to him. The vocabulary is displayed either alphabetically or systematically, and the change-over between both modes must be readily possible (e.g. by pressing a function key).

The user interface should be so designed as to help the user to develop his best search strategy. This includes in particular that tools must be offered for selecting the search terms and for expanding or reducing the retrieval results. As the menu mode can offer only a limited measure of retrieval convenience, the user should be guided by these aids to the command level.

In conclusion we will quote Pauline A.COCHRANE, who has very ably summed up the entire discussion around the subject access element as follows: "The question is not free text versus controlled searching, nor is it Boolean versus non-Boolean searches. The question is 'How can we create a catalog that brings works together, does not separate related subjects or conceal information, and allows the user to search with ease and little difficulty no matter whether the query is specific or general'" (71).

Notes:

1 It was found that 70% of the subject searches in traditional catalogs search for only one term (see (11)). In an OPAC the user, however, searches on the average by 5 different terms (see 10). This can be explained probably by the fact that a further attempt does not mean at the same time a change of location. In addition the new medium challenges the user and entices his joy to play with the computer (see 10, p.2)
2 See (9, p.124) and (3).
3 The authors assume that an effective search in an OPAC must be based on a controlled vocabulary (which means the application of the addition method). A mere free text search is deemed insufficient, as by the missing terminology control the retrieval result would show too high a noise rate.
4 See Section 5.2
5 This is mirrored in the numerous references having appeared on this subject, see (16-24). A negative assessment of classification systems in OPACs is given by J.HILL in (24).
6 The present projects preparing the Library of Congress Classification for online retrieval show, however, that it is possible to attach to every classification system (also a posteriori) a structure reproducing notation, see (25) and (26)
7 Thus one can access the prepared subject index of the Universal Decimal Classification in the online catalog ETHICS at the Technical University of Zürich (see (27). K.MARKEY also tried to search with prepared class descriptions in a project utilizing the Dewey Decimal Classification, see (20,21), cf. also (16).
8 A problem already referred to by R.FUGMANN, see (12).
9 See the detailed presentation in (12).
10 That this request is not self-evident is to be seen, for instance, in the utterance of E.FAYEN on "phrase searching": "The process is analogous to what be required in the card catalog and does not present a problem for many searches." (31, p.76).
11 A 'basic index' is a multidisciplinary main index in which a number of indexes have been compiled into an additional index.
12 A demonstration of the problem is shown in (37).
13 Cf. R.FUGMANN (12), W.GÖDERT (37), and A.PITERNICK (34)
14 'Suggestive prompts' are messages from the system, showing the user which are the possibilities at this point of his dialogue. They are indirect help measures, not necessarily to be followed. Cf. (45).

15 Masking and truncation are mostly used synonymously. In this connection, however, we would like to distinguish as follows: Masking has the advantage that the display ends with the word which is the last one to show the word stem put in. In truncation further words are displayed and it is possible to go on with browsing further to the word stem put in.

16 In Walt CRAWFORD's book (55) numerous possibilities of variation are given.

17 See the detailed explanations in (56) as well as HILDRETH in (45)

18 About this A.LIPOW wrote very aptly: "Since making the system user-friendly means that the patron is always presented with a manageable set of choices, and since you can not write a set of choices for every conceivable situation, "user-friendly" to me is synonymous with limited services", see (56).

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Meeting on Concept Relationships

As in previous years, Prof.Rudolf WILLE and his research group of the Mathematical Institute, Technical University of Darmstadt invited on behalf of his Research Group and the Special Interest Group on Concept Analysis of the German Society for Classification to participate in an introductory course on formal concept analysis (March 8-9) and afterwards (March 9-11) in a meeting on concept relationships. According to the list of participants, some 74 persons attended the latter at which 18 papers were presented and discussed. However, there were only a few concerned expressedly with concept relationships in a more or less philosophical-logical, psychological and linguistic way; thus there seemed not to be something really new in the sense which is needed in the construction of conceptual or classification systems as such. There were, however, a few papers with strikingly new ideas which ought to be considered in the development of the field of concept analysis. It is to be hoped that the organizers of this meeting would do something about their publication.

In the following list of papers (in the sequence of their presentation) I will mark those with an asterisk of which I thought they contain important research findings and should be published soon: I.DAHLBERG, Frankfurt: Kants analytische und synthetische Urteile und ihre begrifflichen Relationen. – E.TEGTMEIER, Mannheim: Verwandtschaft und Unverträglichkeit zwischen Eigenschaften. – R.HULE, Innsbruck: Pragmatische Begriffsanalyse I: Theoretische Grundlagen. – *J.ZELGER, Innsbruck: Pragmatische Begriffsanalyse II: Vorläufige Erfahrungen und Ergebnisse. – *B.GANTER, Darmstadt: Begriffssysteme mit Symmetrie. – *F.VOGT, Darmstadt: Datenanalyse auf der Grundlage einer begrifflichen Datei. – *R.FRITZSCHE, Halle: Merkmalsimplikationen bei der Erdfernerkundung. – *R.WILLE, Darmstadt: Begriffliche Wissenssysteme. P.LUKSCH, Darmstadt: Das automatische Lernsystem PINOCCHIO aus begriffsanalytischer Sicht. W.L.FISCHER, Erlangen: Topologische Invarianten von Inzidenzmatrizen und Anwendungen. – K.E.WOLFF, Darmstadt: Anwendungen subjektiver Maße der begrifflichen Skalierung. – N.SPANGENBERG, Frankfurt: Begriffliche Erhebungstechniken in der Familientherapie. – B.RÜTTINGER, A.SOURISSEAUX, Darmstadt: Komponenten der Arbeitsqualität. *G.SCHAEFER, Hamburg: Der Begriff 'Leben' und seine Relation zu Nachbarbegriffen. – J.SCHÄFER, Darmstadt: Ethik und Pathologie der Metapher. – *K.MUDERSBACH, Heidelberg: Fehlentwicklungen in der Extension-Intension-Unterscheidung. – G.RAHMSTORF, Heidelberg: Vergleich von Begriffen und Relationen aus linguistischer Perspektive. – *J.HELLER, Regensburg: Zur meßtheoretischen Begründung der Repräsentation von Begriffsrelationen in der Psycholinguistik.   I. Dahlberg