Bridging the Gap Between Database Indexing and Book Indexing

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ABSTRACT: Traditionally, *database indexing* and *book indexing* have been looked upon as being quite distinct and have been kept apart in textbooks and teaching. The traditional borderline between both variations of indexing, however, should not conceal fundamental commonalities of the two approaches. For example, *thesaurus construction and usage*, quite common in databases, has hardly been encountered in book indexing so far. Database indexing, on the other hand, has hardly made use of *subheadings* of the syntax-displaying type, quite common in book indexing. Most database users also prefer *precombining vocabulary units* and reject *concept analysis*. However, insisting on precombining descriptors in *a large database* vocabulary may, in the long run, well be destructive to the quality of indexing and of the searches. A *complementary approach* is conceivable which provides both precombinations and analyzed subjects, both index language syntax and subheadings, and provides access to an information system via precombinations, without jeopardizing the manageability of the vocabulary. Such an approach causes considerable costs in input because it involves a great deal of intellectual work. On the other hand, much time and costs will be saved *in the use* of the system. In addition, such an approach would endow an information system with survival power.

1. Introduction

Traditionally, *database indexing* and *book indexing* have been looked upon as being quite distinct and have been kept apart in textbooks and teaching. This has been justified in view of the differences which prevail among the two approaches with respect to file size, vocabulary size, the demands made on vocabulary perspicuity, expected or necessary professionality in vocabulary usage, the degree of precombination and concept analysis, and the technology available for storage and retrieval.

This borderline, however, should not be permitted to conceal fundamental commonalities of the two approaches. For example, the desiderata of representational predictability and representational fidelity hold true for both types of indexing. Means of satisfying these desiderata in one of both approaches may well be useful in the other approach, too.

2. Possible Improvements in Book Indexing

In the following section we shall discuss some features of database indexing which may well be useful for good book indexing, too.

2.1 Faceted thesauri in book indexing

Faceted thesaurus construction and usage, quite common in databases, are hardly encountered in book indexing so far. Rather, concept relationships have been displayed by "see also" references in printed indexes. This causes considerable scatter of closely related headings in the alphabetical arrangement of the index.

Furthermore, this type of referencing has been more intuitive and incomplete rather than logical and comprehensive. These references are entered just as they come to the indexer's mind. The result is that both the indexer and the searcher may become overtaxed in tracing all conceptually related headings.

Optimally, book indexing, too, should be based on carefully designed thesauri, being developed during the indexing procedure. (cf. Mulvany, 1994, p.278; Calvert, 1996; White, 1995, p. 45). This holds true in particular for multiauthored works (Mulvany, 1994, 143). This requires both adequate knowledge of the routine of thesaurus construction on the part of the indexer and the availability of software which includes indexing and thesaurus construction capabilities. These desiderata are only rarely encountered in combination.

However, an indexer who is equipped with these conceptual and technological tools would be able to produce better indexes in less time. This indexer would also be able to assist in thesaurus construction in a variety of projects where good thesauri are vital for the survival of the project in the more or less distant future.

A publisher is well advised in attaching much importance to good book indexes which are heavily used by the readers for look-up purposes. Even an increased expense for such indexes may well be justified in view of the improved usability of the book.

2.2 Systematic Indexes for Books

If the various concepts dealt with in a book can be arranged in logical and commonly acceptable hierarchies, another outcome of careful indexing and integrated indexing software can be produced: In the *systematic index*, as opposed to the alphabetical index, the subject headings are displayed in systematic, rather than alphabetical order, and under each subject heading the corresponding subheadings and locators are presented. Thus, the alphabetical scattering of closely related subject headings is avoided and much time is saved on the part of a searcher who is interested in a topic of a wide scope of subtopics (Fugmann, 1993, p.130). Here, for example, the *super*ordinate subject headings to "Syntax" ("Index languages", "Indexing in general") are also brought in spatial proximity to the subject heading of the searcher's subject heading of his first choice, and he is reminded of them for closer inspection as a search parameter. For the topic of syntax, the following list shows what a systematic index would look like (locators omitted here):

Indexing in general
- controlled indexing
- mandatory indexing
- free indexing

....

Index languages
- vocabulary
- syntax
  - case grammar
  - facet sequence
  - noun phrases
  - operators
  - adjanceny operators
  - roles
  - segmentation
  - relation indicators
  - links
  - syntactical terms
  - topological approach

So far, the lack of software for compiling these indexes and of the lack of space in the printed books have been obstacles to the introduction of systematic indexes. Lack of acceptance on the part of the majority of the readers, who only rarely take the trouble to make themselves familiar with them (in spite of their usefulness in the aforementioned circumstances), has also been an obstacle. However, systematic indexes are only useful in those fields where commonly acceptable hierarchies can be constructed. Hierarchies of an artificial or idiosyncratic type would be useless for an index user (cf. Wellisch, 1995, p. 70).

2.3 Indexes in the Internet

Limitations of space have often forced the indexer to reduce size and quality of the index, or even to completely rewrite the index, and this under extreme time pressure. In the Internet, book indexes could be made available without claiming printing space and causing extra costs. The owner of a book could be authorized for downloading the index into a personal file.

In such a publication scheme, the index can be prepared even while the book is already in print. The index is supplied in the electronic version after the book has already appeared. Doing away with the time pressure, from which the indexers notoriously suffer, will also be much in the interest of the quality of the index.

3. Possible Improvements in Database Indexing

Database indexing could significantly be improved in several respects if some of the experience in book indexing was better utilized.

3.1 Subheadings in Database Indexing

In book indexing, subheadings represent a good deal of the syntactical relations, in which a subject heading is embedded at the location of its occurrence in a book (cf., for example, Anderson 1992; Wittmann 1995, p. 7). But the wording in which subheadings are encountered is unpredictable because they are phrased without the assistance of any controlled vocabulary. Therefore, they are hardly suitable for *mechanized* database searches. Hence, subheadings are effective only in the *visual* scanning of the responses to a query. This type of *natural language* syntax in subheading phrases is most informative to the reader and does not need special assistance or training.

In addition, the majority of database users would be reluctant to make use of any type of (necessarily artificial) *index language syntax*. The consequence of this renunciation of any type of *index language* syntax is lack of both precision and completeness of the re-

trieval in databases (cf., for example, Green, 1995, p. 367).

Database users, however, would appreciate the possibility of at least *visually* scrutinizing and selecting the results of mechanized database searches. They would not always have to refer to the original texts in order to make sure that the subject heading of their interest appears in just the desired context at the location indicated in the electronic index. Thus, *syntax-displaying subheadings* could resolve at least some of the syntactical search problems, common to database searching.

In book indexing, subheadings of this type are commonly being restricted to those subject headings which are posted with at least half a dozen locators. This is again due to the space limitations in book indexes, at least in part. Under the proposed scheme, *each and any* subject heading should be appended by a subheading. In such a highly informative index, the searcher will be given the best possible assistance in searching for those topics, too, which are less highly posted with locators.

Such a comprehensive type of subheading formation, however, will make high demands on the attention and carefulness of the indexer: Many subheadings will comprise a topic for which there is already a subject heading in the index. This requires extensive cross referencing of a particular type. For example, an index entry may read (appended by locators):

Notations

lexicalization of concepts through 2, 5, 7 and the index language vocabulary may have the subject headings "Lexicalization", "Concepts". This requires appending the corresponding subheadings:

Lexicalization

of concepts through notations 2, 5, 7

Concepts

lexicalization through notations 2, 5, 7

The higher the conceptual complexity of a subheading, the greater the necessity of cross-referencing of this type. The indexer is well advised to carefully lead a meticulous *indexing protocol* during indexing in order to make sure that no necessary index entry is omitted. An excellent overview of the vocabulary is necessary during indexing in this case. Also necessary as an aid to this work are a powerful indexing and thesaurus software. This overview may easily be impaired through an abundance of precombinations in the vocabulary, as is shown in the next section.

3.2 Dealing with Precombinations in Database Indexing

Precombinations constitute *the* core problem in the design and maintenance of an index language for large information systems. Their survival will crucially depend on a well-considered balance between precombination and concept analysis. In the view of this article, *"precombination" is combining the meaning of two or more units of the vocabulary into one individual vocabulary unit (classification number, descriptor) of its own.* (A necessary extension of this definition will be presented below).

The concept of precombination is alien to most information searchers because they are not interested in the structure and fate of an index language. In our colloquial and technical language we unhesitatingly combine concepts and create specific lexical units for them in case of desirability without causing any harm through the coining of such expressions. How many concepts are combined in "AIDS" (Acquired Immune Deficiency Syndrome), in "Aquaplaning" or in "Thalassophobia" (a pathological aversion towards the entering of any type of sea vessel)? Information searchers are also accustomed to precombinations through their use of printed indexes, where precombining, syntax-displaying subject headings are necessary and quite common.

Hence, the idea and necessity of concept analysis in an information system is entirely unknown to the vast majority of the information searchers. Therefore, many database users prefer or even insist on *precombining vocabulary units* and reject *concept analysis.* They are doing this because of their familiarity with expressions of this type and for the sake of their convenience.

3.2.1 The Resolution of Precombinations

However, including precombining descriptors in large *database vocabularies* without restrictions may, in the long run, well be destructive to the perspicuity and manageability of the vocabulary and, hence, to the quality of indexing and of the searches. The vocabulary is bound to expand rapidly and soon to become unmanageable.

For example, in an index language vocabulary there may be the terms "coastal regions", furthermore the names of countries, and also "railway connections". Then, the terms "Coast of Norway" or "Railway traffic in Germany" are precombinations. If there are no objections to this type of descriptors, "rocky parts of the coast of Norway" or "rocky parts of the coast of Norway as birds' breeding place", etc., would soon be introduced, with the idea (and illusion, as we shall soon see) of allowing highly specific searches. Such a type of highly precombining descrip-

tors is quite common in traditional classification systems.

For the same reason, hundreds of other specific breeding places, hundreds of other specific coastal areas, etc., would claim entrance to the vocabulary, too, as well as thousands of descriptors which include an individual country. Both indexer and searcher would soon be overtaxed to find and use just those descriptors which match the concept of interest *most appropriately*, as a consequence of the indexer's decreasing overview of the vocabulary. Over and above, *several* equally appropriate terms for a topic of interest will often be provided for a concept of interest. As a consequence, and as obvious in vocabularies of such a type, the indexers' and the questioners' choice of descriptors for the same concept of interest will be dependent on chance and become unpredictable. *Loss of relevant information* at a steadily increasing extent is the result if the searcher relies on the indexers' choice of precombinations.

If, on the other hand, the searcher is aware of the unreliability in the use of precombinations on the part of the indexer, he will precautionarily include less specific, less highly precombining descriptors in the query as search alternatives, suspecting that an indexer might falsely have chosen them instead of a more specific, more appropriate precombination from the vocabulary. However, including less specific descriptors in the query as search alternatives will inevitably provoke less precise responses.

Consequently, and after all these efforts with precombinations, the same lack of specificity occurs in the responses which was intended to be counteracted through the introduction of these precombinations.

Thus, and in particular in an advanced state of the vocabulary's development, precombinations fail to serve the purpose for which they had been introduced. Many databases have had to be partly or entirely taken out of commission for the reasons of lack of precision and recall, caused by fading reliability in vocabulary usage on the part of the indexers.

Vocabulary unreliability can only be counteracted by vocabulary reduction and *concept analysis*. Here, the conceptual constituents of a compound concept are separated from each other. In principle, only these elementary constituents are held in the vocabulary and not all the (practically infinitely numerous) *combinations of them*. This keeps the vocabulary within the limits of manageability and reliable use, both on the part of the indexer and of the searcher. In the aforementioned examples, such an analysis would yield the elementary conceptual constituents of Germany, Norway, and railway traffic. Descriptors such as German railway traffic and very many other ones of a similar structure would be excluded. A large precombining vocabulary may shrink to one hundredth or even one thousandth of its size.

An instructive example is a database in metallurgy. Here, the individual metals would certainly constitute elementary concepts. Any type of alloy (tens of thousands), can be represented through these few conceptual constituents (a few dozens).

But for all the aforementioned reasons, an indexer or searcher may prefer to approach an information system with precombinations. To serve this clientele without at the same time jeopardizing the entire information system, a procedure of the type described in the following is possible.

The alloy "brass", for example, is a precombination if the individual metals are represented through vocabulary units of their own in the information system under consideration. Here, a precombination, for example "brass", will be accepted by the system, but only as a non-preferred term. It is mechanically translated into an artificial term, say "p", a procedure which is quite common for synonyms. A term like this serves as an indication that the corresponding concept has to be analyzed, in this case into its conceptual constituents "copper", "zinc", "alloy". The advice for this analysis will have to be found in the comment to the descriptor "precombination brass". Thus, both the indexer and the searcher are quickly and conveniently informed what to do with such a precombination *if it comes to mind in indexing or query phrasing*.

Such a manual analysis of precombinations is possible with any adequately effective commercially available indexing software, for example with LIDOS ^{R} 1. *Mechanizing* this analysis would, however, to the best of the knowledge of the author, require specific programming.

In this way, many precombinations can be kept from entering the search file. Only the analyzed concept presentation needs to be addressed in the search. The vocabulary can be kept correspondingly small and easy to manage. But in spite of that, the system can be approached via precombinations. They need not be memorized and need not be used. They become active only at the attempt of using them. Therefore, they do not spoil the vocabulary and do not exert their threat to the vocabulary. They are only held in reserve for the convenience of those system users who prefer to use (or happen to memorize) the precombination. These precombinations can even be excluded from the vocabulary print-out in a correspondingly effective software.

The analyzed version of concept presentation in the file originates either from this manual analysis or from direct input by the indexer. The latter will very probably be the case if in a document the specific term "brass" does not occur verbally, but instead in a

paraphrase like "binary alloys made from copper and zink in the proportion of 1:1". Here, the indexer will probably directly enter "copper", "zinc", "alloy" in the file. Again, nobody needs to remember and to consistently use the precombination "brass" for input or query phrasing. Paraphrasing a concept instead of verbally mentioning it with a lexical unit is quite common in texts. "Concepts in a book are not always stated verbatim" (cf. Mulvany 1994, p. 6).

However, after such an analysis another problem rises: Merely enumerating the conceptual constituents of precombinations will constitute serious loss of specificity and search precision. What is lost now is the specific connectivity in which the constituents co-occur in the document. In one of the aforementioned examples, the result of such an analysis would falsely respond to questions for "railway traffic in Norway" and "coasts of Germany".

In the case of the alloy example, and when different alloys have been indexed in a document (which will very often be the case), many false combinations can be read out of such a mere enumeration of alloy constituents in a search for quite a specific alloy. In large databases, the extent of irrelevant responses to a query from such a source may well be intolerable after such a concept analysis.

Here, we encounter the fundamental dilemma of index language *vocabularies* in large information systems: *Neither through precombinations, nor through concept analysis can the goal of sufficiently precise and complete searches be achieved.*

3.2.2 The Necessity of Index Language Grammar in Large Information Systems

The root of this failure is that in the cases under discussion *the use of grammar has been dispensed with* in the index languages, especially the use of the syntax of such a grammar. Dispensing with grammar *in natural language* would lead to similar failures in communication, too. Hence, *the way-out of this dilemma is introducing index language syntax into the index language.*

The task of this syntax is *to represent those concept connections which have been included in the precombination and which have been disrupted through concept analysis,* and to provide these representations in a *predictable* manner. Otherwise, these concept connections could not be phrased as search parameters with adequate prospects of search success. This can be *achieved through concept re-synthesis by means of syntactical devices, to be provided by the index language, successive to the preceding concept analysis.*

In uncontrolled natural language it is quite unpredictable which syntactical tool of the great variety, available in uncontrolled natural language, an author might have used. Hence, *natural language grammar is not suitable for being addressed by syntactical search parameters.*

This is the reason why advanced index languages, designed for high ratios of precision and recall, need more or less advanced *artificial* syntactical devices.

Often these concept connectivities are only latently included in a precombination, as is the case, for example, in the term of "brass". Here they must be made explicit during indexing.

Concept *analysis* and concept re-*synthesis,* both done in a predictable manner, is the idea of the "analytico-synthetic" approach of the Indian school. An effective combination of practice-proven syntactical tools consists of relation indicators (Fugmann, 1993, p.158) and of the device of segmentation (p.162).

3.2.3 The Restricted Retention of Precombinations

It is due to their artificiality that professional index language syntax will hardly become popular among the casual users of information systems. In addition, only rarely will an index language syntax be able to represent the concept connections that have been disrupted during the analysis at a sufficiently high degree of representational fidelity. For example, merely the enumerating of "copper", "zinc", "alloy" would not reveal the specific *proportion* in which the metals are present in the alloy "brass".

In order to serve this clientile and to mitigate this lack of specificity, precombinations of the aforementioned type "precombination brass", "precombination red brass", etc., could *be assigned to their documents, in addition to the analytic representation of the concept* behind the term.

Under these circumstances, a questioner would, for example, obtain "precombination brass" as a reply and as a "preferred term" after having tried to enter "brass" as a search term. Precisely this term could then be used as a search parameter. All those references would *perfectly precisely* be retrieved which had been entered with this term and which correspond, for example, to the precombination of brass.

Those documents however, which had been indexed in the analyzed version ("copper", "zinc", "alloy") will not be found in such a search. Should high recall be vital in the information system, *re-indexing* is necessary: All documents having been indexed with the analyzed version, for example, with the enumeration "copper", "zinc", "alloy", will have to be retrieved and scanned for the occurrence of the concept of brass. (Not all of them will be hits because the analyzed version lacks precision, as exemplified in the foregoing.) After that, the precombination representing precisely "brass" (here: "precombination

brass") will be attributed to the relevant documents. After that, precise *and complete* searches are conveniently possible for this concept with this precombination, too.

3.2.4 Determining the Borderline between Precombination and Concept Analysis

In the light of the preceding discussion, *the degree to which either concept analysis or precombination is advisable in an information system strongly depends on the availability and effectiveness of the index language grammar, especially on the syntax of such a grammar.*

If in an index language there is only a weak syntax in use, or if it was entirely dispensed with such a syntax (as is normally the case with the vocabulary of book indexes), it may well be advisable to *extensively retain precombinations in the database file, in parallel to the analyzed version of the precombination,* at least for some time, and at least to a certain extent, until final decisions have been made concerning the employment of (a better) syntax.

Under these circumstances, the searcher has the possibility and convenience of using the precombination as a search parameter, being well aware of the fact that the search may be incomplete. The indexer may not have found and used the precombination, which may be buried deep in the vocabulary.

The possibility of searching with the *analyzed version* is also provided. It will yield more complete results in the hands of the experienced or professional information searcher because it highly reliably comprises those documents, too, which have directly been indexed in the analyzed form for the reason discussed in the foregoing.

Thus, the balance between precombination and analysis can be adjusted precisely to the prevailing circumstances and requirements, with a strong and perfectly justified *emphasis on precombination* in book indexes and with an *emphasis on concept analysis* in the indexing for (large) databases, the latter in particular in the presence of a sufficiently powerful index language syntax.

During the continual growth of an information system the necessity of employing advanced conceptual tools, such as index language syntax and category-based concept analysis, will become more and more apparent. At that time, the users and/or their intermediates would appreciate it if their information system had *held in reserve advanced search capabilities.* They would be able to obliterate the consequences of methodological primitiveness to which they had restricted themselves so far. This would be much in the interest of the survival power of an information system.

3.3 Conceptual Categories as a Guideline for Concept Analysis

It is beyond the scope of this article to discuss the beneficial roles that conceptual categories can play in the index language of a database (cf., for example, Frost, 1996, p.185). Only one recommendation should be given in this context, and this will complement the aforementioned definition of precombinations.

A set of conceptual categories may have been agreed upon in an information system, such as persons, institutions, processes, living entities, apparatus, space, time. Then, each concept from such a category claims representation in the vocabulary. Thus, and among several other things, conceptual categories serve as a valuable guideline for the decision of what should be considered as a precombination and, hence, should deserve analysis into its (categorical) components.

Our previous definition of precombination can now be made more complete. If, for example, substances have been chosen as a conceptual category, it is at the same time obvious that "brass" is a precombination, although *zink may not (yet) be represented in the vocabulary.* In the absence of such a rule, the introduction of a new descriptor (for example "zinc") would change many descriptors into precombinations and would *now* require their analysis. During the influx of new descriptors the vocabulary would continually have to be revised, as well as part of the indexing work already having been done.

3.4 Pre-coordination

In the context of this article, it is instructive to consider the concept of "pre-coordination" in some detail. According to a widely accepted definition *pre-coordination is the combining of concepts before a search is undertaken (or before an index is used).*

According to this definition (cf., for example, American National Standard Institute 1984, p.15), pre-coordination comprises:

- precombination (for example: dried vegetables, cotton spinning (Aitchison & Gilchrist, 1987, p.25, 28); rusting, brass if metals are elements of the vocabulary)
- chains of descriptors or of subject headings, structured according to syntactical rules as is done, for example, in the Colon Classification or in PRECIS.

In other words, pre-coordination according to this definition comprises both the *non-analyzed* representation of compound concepts and the *analyzed* representation of concepts.

The formation of a descriptor chain *"before the search"* may well be based on concept analysis and on

successive re-synthesis. Thus, the problems of pre-combinations are largely avoided in this case.

Hence, pre-coordination comprises two entirely different modes of concept representation with quite different features. These representations are brought together on the basis of a quite inessential feature that they have in common: *the point in time* at which they have been formed.

However, a most essential difference between both types of connecting concepts is neglected here: Pre-combination, in contrast to the analyzed representation, will lead to an unmanageable vocabulary and to system breakdown if excessively exercised and operated on the large scale. This is due to its renunciation of concept analysis as we have seen in the foregoing.

It is always difficult to make reasonable statements about a heterogeneous group of extremely different items, i.e. of items which are *different in the essentials* (as seen in the view of the specific subject field) and which have only the *inessentials in common*. What can be said about a set of objects consisting of a pair of shoes, a book and a loaf of bread? They may have the same weight in common. But who may be interested in using such an inessential feature apart perhaps from the person who carries these items home? The items of such a set are different with respect to use, to material, price, durability, edibility, etc. They are different with respect to almost all features that are of interest to most people. The same type of uselessness prevails for the concept of pre-coordination in the meaning defined in the foregoing.

It is for this reason that the term of "pre-coordination" in the preceding considerations has been avoided. Soergel (1985, p. 257) also expressly dispenses with using this term. Svenonius (1995) encountered considerable difficulties in using the term in this twofold meaning [2]. ANSI/NISO Z39.19-1993 (p.37) wisely excludes the meaning of a compound term as a descriptor from the definition of pre-coordination.

4 The Economics of the Proposed Approach

An approach such as the one discussed here causes considerable costs during input because it involves a great deal of intellectual work in the processing of the documents and in the construction and maintenance of the index language vocabulary and grammar. Considerable expert effort is also required for the phrasing of informative and concise subheadings and for continually embedding new subject headings and subheadings into the environment of the already existing ones.

On the other hand, such an approach will save much time and costs because of the precision and completeness of its searches. Furthermore, it may well endow an information system with high survival power and with the certainty that it will remain manageable even in the far distant future, an advantageous feature which is hard to measure financially.

Such an approach is particularly worth considering for the in-house documentation of internal documents if they must be completely retrievable with sufficiently high precision even in the more distant future. Here, one cannot afford abandoning the work of many years of indexing because the system has developed into intolerably low ratios of precision and recall. Here, investing in a cheap but merely ephemeral information system is a waste of time and manpower.

The prospects and quality of automatic indexing is not considered in this article. We can only emphasize the warning: "Don't believe the hype if your package says it can replace the indexer" (Bonura 1994, p. 102). What is compiled by most "automatic indexing programs" is not an index but merely a concordance, i.e. a list of the occurrences of text words (Mulvany 1994, p. 246). This is far from providing sufficient access to the topics dealt with in a text.

Notes

1 Land Software Entwicklung, P.O.B. 1126 D 90 522 Oberasbach.

2 E. Svenonius 1995, p. 252: "It is assumed for simplicity that the complex expressions of a string index language, which are constructed using various kinds of connectives, belong to its vocabulary. This assumption is theoretically distasteful in that the strings of an index language like the sentences of a natural language, are not vocabulary elements per se, but are built out of vocabulary elements..".

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