Bowker, L. (1993). Multidimensional Classification of Concepts for Terminological Purposes. 4th ASIS SIG/CR Classification Research Workshop, 39-56. doi:10.7152/acro.v4i1.12610

Multidimensional Classification of Concepts for Terminological Purposes

Lynne Bowker
Centre for Computational Linguistics
University of Manchester Institute of Science and Technology (UMIST)
United Kingdom
lynne@ccl.umist.ac.uk

1. TERMINOLOGY

Terminology is the science concerned with the linguistic representation of concepts; it entails collecting, describing, processing, and presenting *terms* (i.e. lexical items belonging to specialized subject fields) in one or more languages. Applied work in terminology is carried out in two modes: 1) *punctual term research,* concerned with a single concept-term unit; and 2) *thematic term research*, concerned with mapping out the conceptual structure of a specific subject field or subfield (as exhaustively as possible), and describing all the concept-term units that fall within it. For the purpose of this paper, we will focus on thematic term research as it has wider implications for classification and multidimensionality.

1.1. Classification in Terminology

There is a close relationship between terminology and classification: classification plays a key role in the formation and development of concepts and concept systems, which constitute the cornerstone of terminology work. One possible explanation of concept formation is presented by Sager (1990:22), who says that we begin by identifying individual objects as having certain shared characteristics, and then we abstract some of these characteristics in order to arrive at types of objects (e.g. we identify certain animals as having a number of common features which we group under the concept label "cats"). We may then group the already abstract types of objects into broader classes (e.g. we may group cats with dogs as animals, and set up separate categories for wild and domestic animals). If we continue grouping and ordering concepts in this fashion, we develop a system of concepts where each concept is characterized by the relationships it forms with neighbouring concepts.

As previously mentioned, the goal of a thematic term research project is to map out and describe all the concepts in a subject field. This process comprises five main stages[1]: introductory reading, selection of documentation, scanning, analysis of data, and preparation of the term records. In this section, we will briefly examine how terminologists use classification at each of these stages.

Introductory Reading. When commencing a thematic term research project, terminologists begin by familiarizing themselves with the subject field through introductory reading. As they read,

1. The stages for conducting a thematic term research project that are outlined in this paper represent a synthesis of ideas presented in the following sources: Auger & Rousseau (1978), Cole (1987), Dubuc (1985), Meyer (1992), Picht & Draskau (1985), Rondeau (1984), and Sager (1990).

ISSN: 2324-9773

Bowker, L. (1993). Multidimensional Classification of Concepts for Terminological Purposes. 4th ASIS SIG/CR Classification Research Workshop, 39-56. doi:10.7152/acro.v4i1.12610

they identify general conceptual characteristics and visualize the broad structure of the field, which they often sketch out, usually in the form of a hierarchical tree diagram, such as the ones shown in figures 1-6. The tree diagrams are organized according to some particular conceptual relationship (e.g. generic-specific, part-whole), and they should be revised and updated throughout the research project. In this way, they can represent, in progressively clearer detail, the concept system of a subject field.

Selection of Documentation. Once terminologists have produced a preliminary classification of the subject field, their next step is to select the documentation that will serve as their main source of knowledge for the project. The rough sketch of the concept system prepared during the introductory reading stage can now help terminologists to select a documentary corpus since the names of subfields and key concepts identified in the concept system provide specific entry points into the documentation (i.e. key word searches in databases, indexes, or tables of contents).

Scanning. Once terminologists have selected their documentation, they proceed to scan it, extracting potential terms with their contexts. As they scan documents, terminologists inevitably learn more about the concept system and they are able to fill out their original rough sketch accordingly.

At this stage of the thematic term research, the concept system once again proves invaluable to terminologists as it acts as an indicator of the exhaustiveness of the search for terms (Dubuc 1985:53). In other words, it allows terminologists to 1) identify and eliminate terms that fall outside the boundaries of the subject field, and 2) identify lacunae (i.e., concepts for which terms have not yet been identified in the documentation).

Analysis of Data. The next stage of a thematic term research project is to analyze the data gathered in the scanning stage. The terminologists' goal is to achieve the depth of understanding necessary to define each term, establish interlingual equivalence (in comparative terminology), and establish cases of synonymy. Terminologists carefully analyze the contexts in which the terms have been found in order to identify the characteristics of each concept. These characteristics will be used to define the concept (most often in the classic *intensional* or *genus-differentia style*), and will be compared with those of potentially related terms (e.g. foreign language equivalents, synonyms) in order to determine conceptual matches. Correctly determining the place of each concept in the concept system is crucial for the construction of good definitions and the correct identification of foreign language equivalents or synonyms.

Preparation of Term Records. The final stage of a thematic term research project is the actual preparation of the term records (one record per concept). Traditionally, term records were kept on file cards; however, terminological databases, or *term banks*, are now a more common way of storing term records. Collections of term records are often published as glossaries or vocabularies. To prepare a term record, terminologists compile the relevant data gleaned from the analysis. There are no definitive rules as to what information must appear on a term record; however, it is generally accepted that the record will contain at least the entry terms, the subject field, relevant grammatical information (e.g. part of speech), a definition, synonyms (if there are any), and sources. Traditional term records provide minimal, if any, indication of the relations

ISSN: 2324-9773

Bowker, L. (1993). Multidimensional Classification of Concepts for Terminological Purposes. 4th ASIS SIG/CR Classification Research Workshop, 39-56. doi:10.7152/acro.v4i1.12610

between concepts in a subject field or of an individual concept's place within the concept system. It is encouraging to note, however, that there is a new trend towards including *conceptual relationships* as a category of information to be recorded on term records (Sager 1990:160). Also, in a new generation of term banks, such as the COGNITERM term bank, it is possible to preserve and display the actual concept system representation in the form of either a tree diagram or an indented hierarchical list.

2. MULTIDIMENSIONALITY

It is generally held that classification is the act of uniting like concepts on the basis of a common characteristic, while separating unlike concepts. Therefore, it logically follows that what is like or unlike depends on the characteristic that is chosen. If more than one characteristic can be used to distinguish between the concepts, then the concepts can be classified in more than one way.

In this paper, we will use the term *dimension* to designate a classification that has been produced by classifying concepts on the basis of one particular differentiating characteristic. In other words, a dimension represents one way of classifying a group of concepts. In a case where there are two differentiating characteristics to choose from, the concepts can be classified in two ways; therefore,

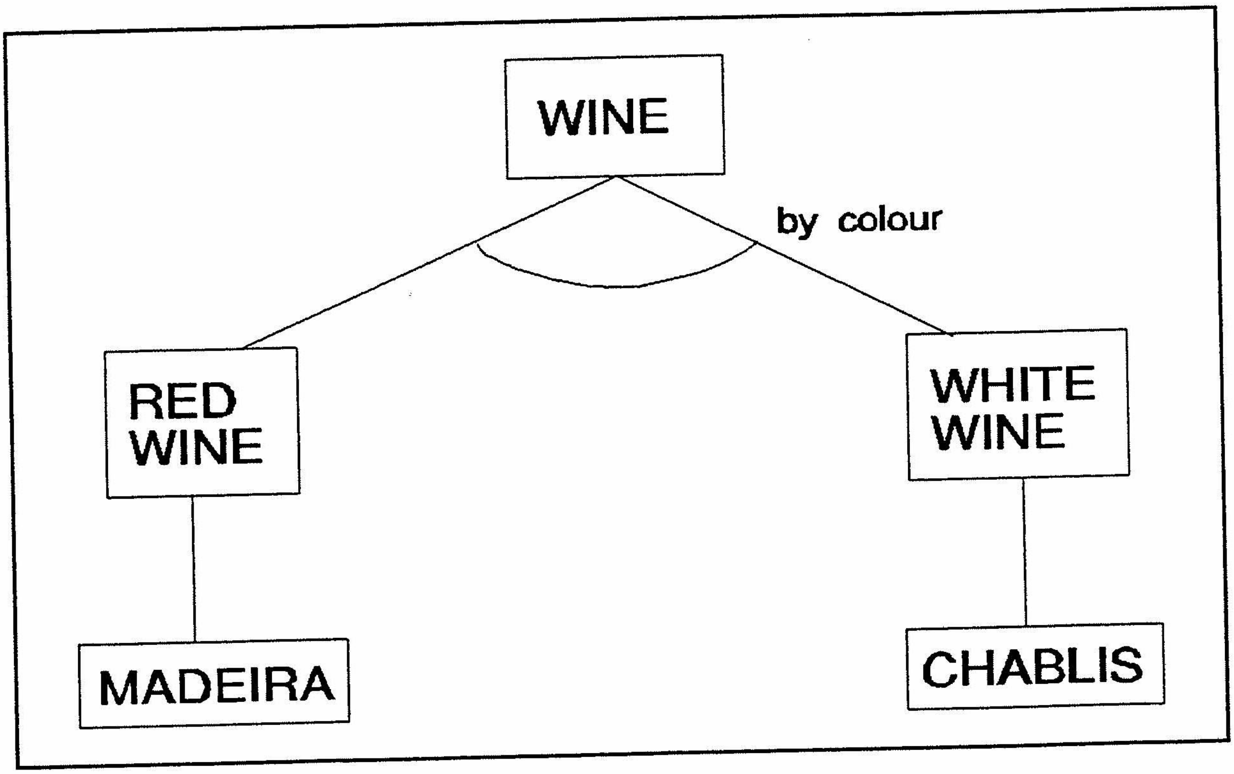

Figure 1. A unidimensional classification of WINE.

ISSN: 2324-9773

Bowker, L. (1993). Multidimensional Classification of Concepts for Terminological Purposes. 4th ASIS SIG/CR Classification Research Workshop, 39-56. doi:10.7152/acro.v4i1.12610

there are two dimensions. A class which has been given only one dimension is said to be *unidimensional,* while a class which has more than one dimension is *multidimensional*.

For example, the representation of the concept WINE shown in figure 1 is unidimensional: WINE is classified solely on the basis of the characteristic "colour", producing the subordinate concepts RED WINE and WHITE WINE.

However, there are actually several ways in which WINE can be classified, based on the different characteristics that WINE can have. For example, WINE can also be classified according to the characteristic "sugar content," producing the subordinate concepts DRY WINE and SWEET WINE. Alternatively, WINE could be classified according to the characteristic "country of origin", producing subordinate concepts such as FRENCH WINE and SPANISH WINE. If all three ways of classifying WINE are considered simultaneously, then the representation is multidimensional, as shown in figure 2. As the figure indicates, some concepts, such as CHABLIS or MADEIRA, can be members of several dimensions. Since any given concept can have numerous subclassifications, and since the concepts in the subclassifications can themselves have multidimensional classifications, multidimensionality can be a potentially complex phenomenon indeed.

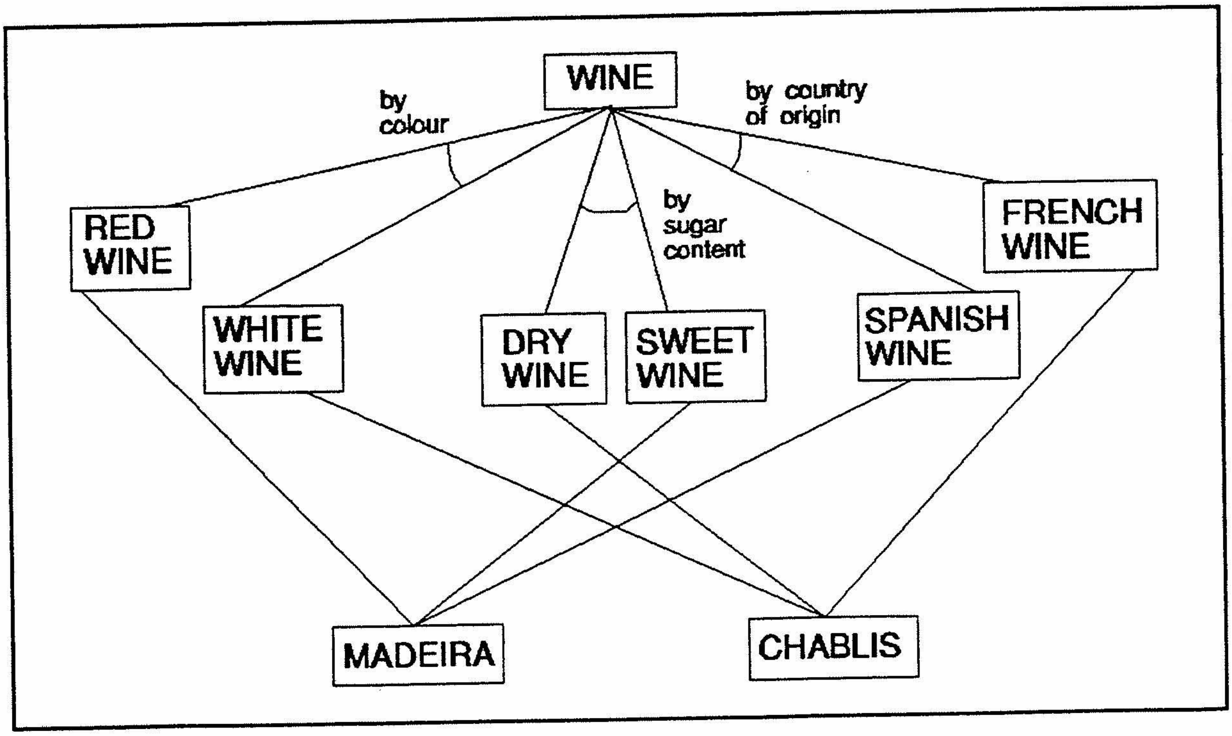

Figure 2. A multidimensional classification of WINE.

ISSN: 2324-9773

Bowker, L. (1993). Multidimensional Classification of Concepts for Terminological Purposes. 4th ASIS SIG/CR Classification Research Workshop, 39-56. doi:10.7152/acro.v4i1.12610

2.1. Multidimensionality in Terminology

We saw in section 1.1 that creating accurate and functional concept systems based on a sound knowledge of classification techniques is essential to good terminological analysis. This knowledge includes the recognition and representation of multidimensionality. Experienced terminologists are well aware that the vast majority of subject fields contain multidimensional classifications; nevertheless, to date, most of the concept systems illustrated in terminology textbooks are deceptively simple and tidy representations that show only one possible way of classifying a subject field.

It is important for terminologists to be able to deal with multidimensionality because a terminology project based on a unidimensional classification is likely to be of a poorer quality than one based on a multidimensional classification. Although it is clearly much easier for a terminologist to work with a single dimension, we believe that a multidimensional understanding of a subject field is more substantial than a unidimensional understanding (Picht & Draskau 1985:69), and will lead to the production of higher quality definitions, foreign language equivalents, etc.

A second very important reason for acknowledging multidimensionality when conducting a terminology research project is to avoid omitting concepts that are relevant to the subject field at hand. Some concepts (and hence terms) appear in only one dimension, so if all dimensions are not considered, then pertinent terms may be omitted from the term bank or terminological publication.

3. A KNOWLEDGE ENGINEERING APPROACH TO HANDLING MULTIDIMENSIONALITY

The reason that multidimensionality has been virtually neglected in the field of terminology is that until recently, terminologists were limited to working with traditional pencil-and-paper methods, which are not conducive to handling potentially complex multidimensional representations. Fortunately, recent developments in computer technology, particularly the subfield of Artificial Intelligence (AI) known as Knowledge Engineering, have provided tools which offer exciting possibilities for tackling multidimensionality.

3.1. COGNITERM and CODE

Our research has been carried out in the broader context of the COGNITERM Project, which aims to construct a prototypical terminological knowledge base (TKB) featuring a rich and formally structured knowledge component. COGNITERM can best be described as a hybrid between a conventional term bank and a knowledge base (KB) as this concept is known in AI. This TKB, which currently contains several hundred concepts in the subject field of optical storage technologies, is being constructed using a knowledge engineering tool called CODE *(Conceptually Oriented Description Environment)*, developed at the Artificial Intelligence Laboratory of the University of Ottawa, Canada.

ISSN: 2324-9773

Bowker, L. (1993). Multidimensional Classification of Concepts for Terminological Purposes. 4th ASIS SIG/CR Classification Research Workshop, 39-56. doi:10.7152/acro.v4i1.12610

The CODE system and the COGNITERM Project are well documented in the literature (Meyer 1993, 1992; Meyer *et al.* 1992a/b; Skuce & Meyer 1991, 1990); therefore, we will limit ourselves to a very brief overview here. CODE is designed to help users create, modify, format, and retrieve knowledge from, a KB that has both a textual and graphical form. The KB is organized into units called *conceptual descriptors* (CDs) (corresponding to term records), which can be arranged in inheritance hierarchies. CODE features that are useful for terminological research include: a sophisticated graphical display, automatic updating between the textual and graphical forms of the KB, a hypertext-like browsing capability, mechanisms for inheritance and the detection of inconsistencies, a flexible means of specifying conceptual attributes and relations, and the possibility of handling multidimensionality.

3.2. CODE Support for Handling Multidimensionality

Any systematic attempt to handle multidimensionality must be grounded in sound classification techniques. CODE provides a variety of general support features for facilitating classification, as well as other support features that are directly relevant to handling multidimensionality.

Explicit recording and hierarchical structuring of characteristics. CODE requires that conceptual characteristics be recorded in a slot-filler format typical of many knowledge-based systems. The slot contains the characteristic name, and the filler the characteristic value (e.g. colour: red). Any characteristic can have its own characteristics, called facets. With specific regard to multidimensionality, a characteristic upon which a dimension is based could be identified as such within a special facet designed for this purpose. Characteristics can be organized into user-defined hierarchies; we generally classify them into attributes and relations. Relations in turn are classified into hierarchical and non-hierarchical relations, and the hierarchical ones are classified into generic-specific and part-whole. A dimensional relation (called a kind in CODE) is one particular type of generic-specific relation. This highly systematic approach to structuring characteristics helps avoid classification hazards such as *false multidimensionality,* described in section 4.1 *(Guideline 4).*

Mechanisms for inheritance and detection of inconsistencies. In concept systems dominated by generic-specific relations, CDs are arranged in inheritance hierarchies so that the characteristics of more general concepts are automatically inherited by more specific concepts. Of particular interest for multidimensionality is that CODE allows the possibility of multiple inheritance: a concept can have any number of superordinate concepts, including superordinates from different dimensions (see figures 2 and 5). Associated with inheritance mechanisms are various types of support features for detecting inconsistencies, a very important issue when dealing with complex multidimensional structures. When any change is made at a high hierarchical level, it will filter through to the lower levels because of inheritance. Any inconsistency, such as a mismatch between the inherited value and a user-specified value lower in the hierarchy, is automatically signalled to the terminologist.

Graphical support for multidimensionality. Because multidimensionality can be so complex, it is essential for terminologists to have graphical support in order to help them keep the knowledge properly organized. CODE has a sophisticated graphing feature which allows

ISSN: 2324-9773

Bowker, L. (1993). Multidimensional Classification of Concepts for Terminological Purposes. 4th ASIS SIG/CR Classification Research Workshop, 39-56. doi:10.7152/acro.v4i1.12610

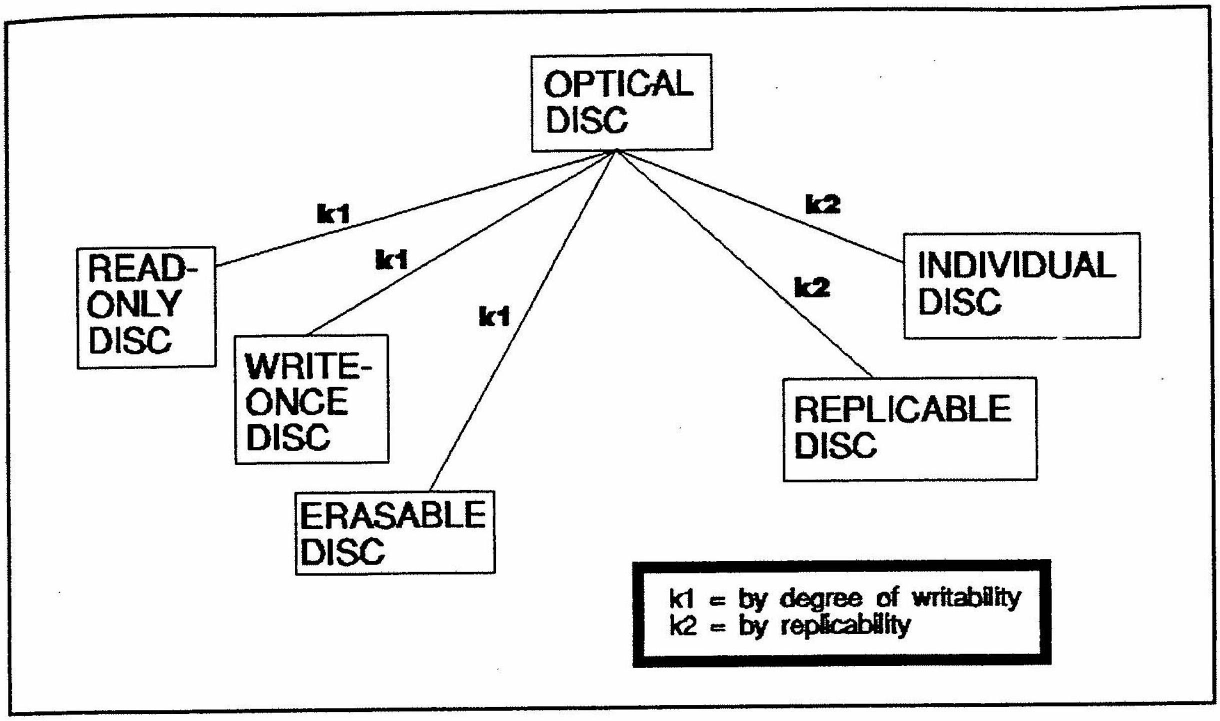

Figure 3. An initial concept system representation of the subfield *optical discs*.

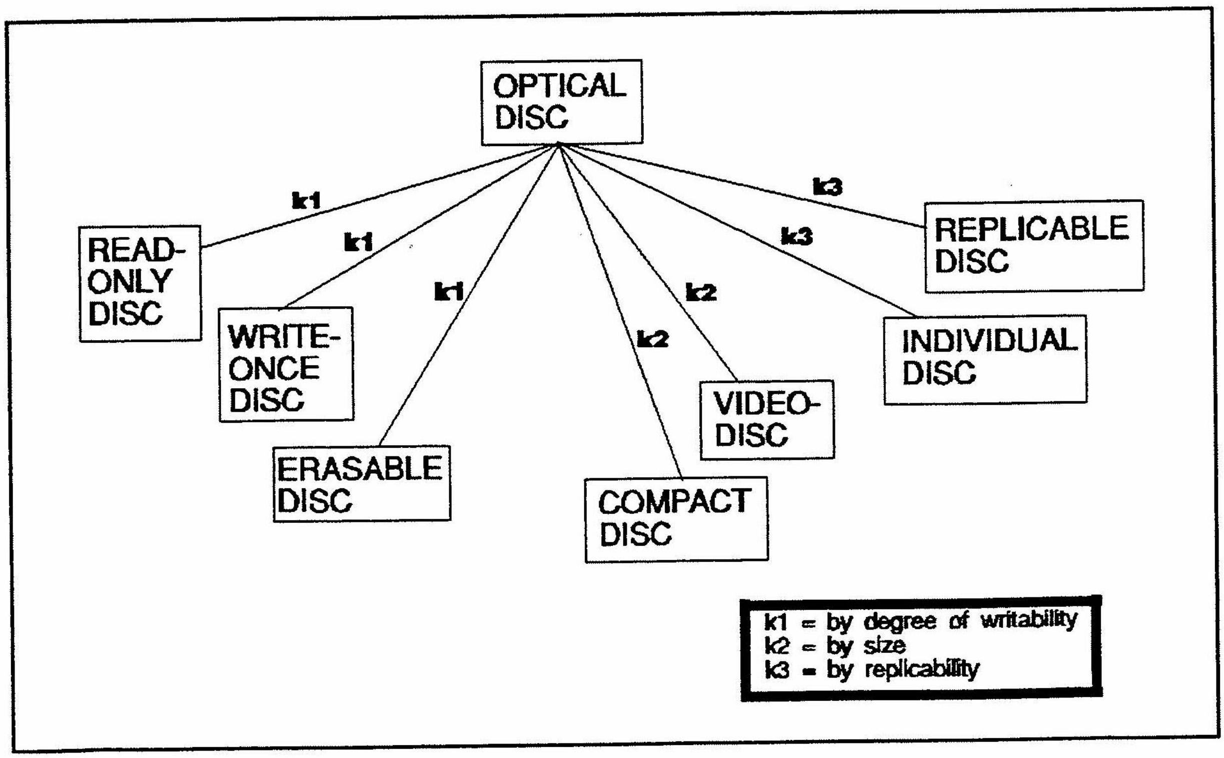

Figure 4. A more advanced concept system representation of the subfield *optical discs* showing an altered ranking order.

ISSN: 2324-9773

Bowker, L. (1993). Multidimensional Classification of Concepts for Terminological Purposes. 4th ASIS SIG/CR Classification Research Workshop, 39-56. doi:10.7152/acro.v4i1.12610

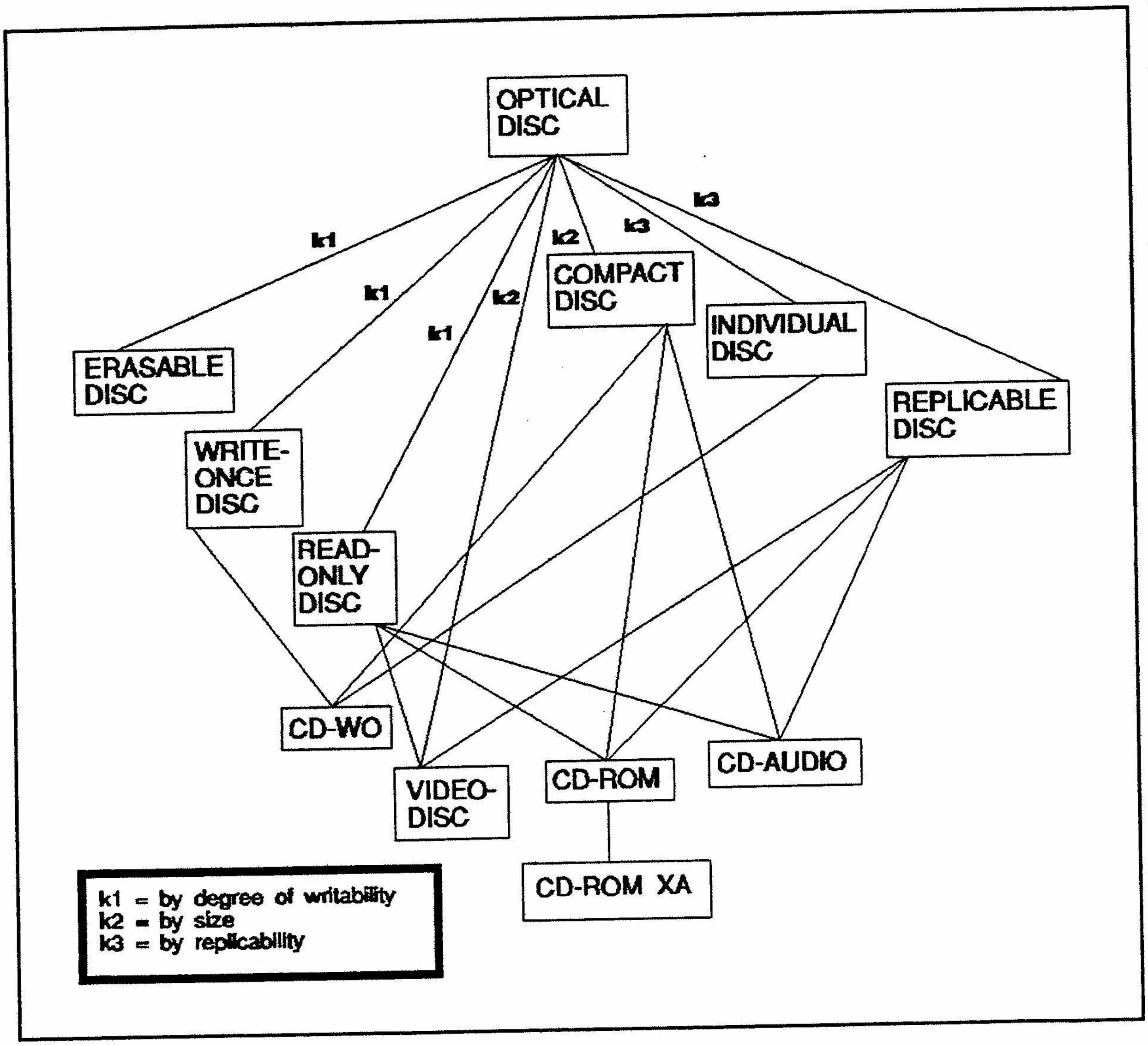

Figure 5. **A final multidimensional representation of the subfield** ***optical discs.***

ISSN: 2324-9773

Bowker, L. (1993). Multidimensional Classification of Concepts for Terminological Purposes. 4th ASIS SIG/CR Classification Research Workshop, 39-56. doi:10.7152/acro.v4i1.12610

terminologists to produce tree diagrams. Dimensions (called *kinds* in the CODE system) are specifically labelled with a k (for kind) on the concept system representation. The relative importance of a dimension (as determined by the terminologist based on information provided in the documentation or by subject field experts) is reflected by a number value following the k-label (e.g. k1, k2). Numbered k-labels are shown in figures 3-5. If the terminologist wishes, the name of the characteristic underlying any dimension (e.g. "colour" or "sugar content") can automatically be included on the graph along with the ranking order, or, if this causes the graph to become too cluttered, it can be very quickly accessed in the textual form of the KB.

Masking facilities. Though it is important to recognize all the dimensions of a classification, it can be confusing to be faced with several dimensions at the same time. CODE has a masking facility that allows the terminologist to request that either the graph or textual form of the KB be restricted to show only concepts having a given dimensional characteristic (e.g. "colour"). Because of the automatic inheritance of characteristics, this request would result in a full representation of a single dimension being displayed; in other words, all concepts in the system having the specified dimensional characteristic, regardless of their level in the hierarchy, would be shown.

4. PROPOSED GUIDELINES FOR HANDLING MULTIDIMENSIONALITY

The following set of proposed guidelines[1] is derived from two sources: 1) insights culled from our investigation of classification methods in the fields of terminology, biological taxonomy, and information science; and 2) practical informal experimentation with the COGNITERM TKB.

In order to document our guidelines more clearly, we have separated them into two distinct operations: guidelines for *recognizing* multidimensionality in specialized documentation, and guidelines for *representing* multidimensionality once it has been recognized. However, the procedure for handling multidimensionality is not strictly sequential; there is some overlap between the two operations, and some steps may need to be repeated.

In the following two tables, the left-hand column lists the proposed guidelines for recognizing (table 1) and representing (table 2) multidimensionality, while the right-hand column summarizes how the CODE system facilitates the performance of these tasks.

4.1. Explanation and Illustration of the Proposed Guidelines

In this section, we provide a more detailed explanation of each of the proposed guidelines listed in the tables above, along with some illustrations of their application, taken from a multidimensional representation of the subfield optical discs, found in the COGNITERM TKB on the subject field optical storage technologies.

1. A more detailed description of the guidelines and their development can be found in Bowker 1992.

ISSN: 2324-9773

Bowker, L. (1993). Multidimensional Classification of Concepts for Terminological Purposes. 4th ASIS SIG/CR Classification Research Workshop, 39-56. doi:10.7152/acro.v4i1.12610

Guidelines for Recognizing Multidimensionality	*Technical Support in CODE for Recognizing Multidimensionality*
1) Work with a graphic representation, ideally a tree diagram, of the concept system. (If such a representation is not found in the documentation, create one.)	• CODE's graphing facility can be used to sketch out a rough tree diagram representing the concept system. Users enter the concept name, and click on its superordinate concept(s). Nodes and links are generated automatically.
2) Consider all possible ways of classifying a subject field at all levels of the classification.	• The CODE graph gives an overview of the entire subject field, making it easier for users to determine if all ways of classifying the subject field have been considered.
3) Recognize indications that multidimensionality exists (e.g. repetition of concepts, use of different contrasting lexical pairs).	• CODE automatically signals the user if the same concept or characteristic is entered into the KB in more than one place.
4) Identify and correct false multidimensionality.	• CODE forces users to employ good classification techniques by 1) recording characteristics in a slot-filler format, and 2) providing mechanisms for inheritance and detection of inconsistencies.

Table 1: Recognizing Multidimensionality

Guideline 1)

Explanation: If terminologists graphically record the concept system representation (i.e. sketch a tree diagram) right from the introductory reading stage, they will get a clearer picture of the subject field, and will be able to recognize multidimensionality more easily. Sometimes, such graphical representations can be found in the documentation; however, if no adequate representations are readily available, terminologists may find it helpful to construct their own based on the information they find in the documentation (e.g. tables of contents, organizational structure of articles), and/or during discussions with subject-field experts.

Example: When beginning our terminology project on the subfield of optical discs, we commenced by reading introductory literature in order to familiarize ourselves with the subject field. In these documents, we encountered tree diagrams, tables of contents, and explanations. We amalgamated this information, and used CODE's graphing facility to sketch out the main divisions of the subject field. Our initial concept system representation is shown in figure 3.

ISSN: 2324-9773

Bowker, L. (1993). Multidimensional Classification of Concepts for Terminological Purposes. 4th ASIS SIG/CR Classification Research Workshop, 39-56. doi:10.7152/acro.v4i1.12610

Guidelines for Representing Multidimensionality	***Technical Support in CODE for Representing Multidimensionality***
5) Work on one dimension at a time.	• CODE's masking facility allows users to focus on one dimension at a time.
6) Rank the dimensions.	• CODE's "kinds" field allows users to enter concepts in different dimensions in the order of ranking, which is indicated on the graph with numbered k-links.
7) Clearly distinguish the different dimensions on the graphic representation.	• k-links on CODE graphs are automatically numbered (one number per dimension).
8) Clearly indicate the characteristic underlying each dimension in a place that is easily accessible to the user.	• CODE allows the name of the characteristic underlying each dimension to be recorded in both the graphical and textual forms of the KB.
9) Revise the graphic representation of the concept system as more is learned about the subject field.	• CODE has many features to facilitate revision: automatic updating between graph and text; inheritance and detection of inconsistencies; possibility of rearranging and reparenting concepts.

Table 2: Representing Multidimensionality

Guideline 2)

Explanation: Although a unidimensional representation of a subject field may suit some purposes (e.g. if the concepts in question only have to be classified to meet one particular need), it can pose serious problems for terminology, as explained in section 2.1. In order for a representation to be multidimensional, *all* possible ways of classifying every concept must be reflected at each level of the classification.

Example: When conducting this terminology project, we did not restrict ourselves to considering only one possible classification of the subfield optical discs; we incorporated all the classifications that we found into a multidimensional representation shown in figure 5.

Guideline 3)

Explanation: Multidimensionality is not always obvious, so terminologists should be able to recognize signs indicating the presence of multidimensionality, even when it is not explicitly expressed. For example, different documents may contain different breakdowns of the subject field based on different viewpoints, or different authors may use different vocabulary, particularly different sets of contrasting lexical pairs.

ISSN: 2324-9773

Bowker, L. (1993). Multidimensional Classification of Concepts for Terminological Purposes. 4th ASIS SIG/CR Classification Research Workshop, 39-56. doi:10.7152/acro.v4i1.12610

Example: In our reading, we discovered that different authors proposed different classifications of the subject field based on different viewpoints. For instance, Chen (1989:5) classified optical discs from the viewpoint of *users*, who are primarily interested in whether they can write information to the disc, or merely retrieve information that has been stored there by the manufacturer. Hence, Chen classified OPTICAL DISC solely according to the characteristic "degree of writability" into the subordinate concepts READ-ONLY DISC, WRITE-ONCE DISC, and ERASABLE DISC. Meanwhile, Heimburger (1990:32) classified optical discs from the viewpoint of *manufacturers*, who are concerned with whether they are required to produce a pre-recorded disc or a blank disc. Thus, Heimburger classified OPTICAL DISC solely on the basis of the characteristic "replicability" into the subordinate concepts REPLICABLE DISC and INDIVIDUAL DISC.

Guideline 4)

Explanation: In addition to recognizing true multidimensionality, terminologists should also be able to identify and correct *false multidimensionality* (Bowker 1992:75). False multidimensionality is a classification error that occurs when a concept is classified at one level of the hierarchy on the basis of two (or more) characteristics that should be applied within the *same* dimension, but at *different* levels. False multidimensionality is undesirable because it results in conceptual confusion and the omission of concepts.

Example: We encountered numerous examples of false multidimensionality in our project on optical storage media. In figure 6a) (adapted from Chen 1989:5), the class READ-ONLY MEDIA has actually been subclassified on the basis of two different characteristics: 1) "physical form" and 2) "size". In other words, the subclasses COMPACT DISC and VIDEODISC have the value *disc* for the characteristic "physical form", and are therefore different from the other forms of media with the values *film* and *tape*. However, in addition to differing from other types of media by their "physical form", COMPACT DISC and VIDEODISC also differ from each other on the basis of the characteristic "size": compact discs are 4.72 inches in diameter, while videodiscs are 12 inches in diameter. This classification error has resulted in the omission of the concept (and hence term) OPTICAL DISC. A more correct classification, which includes the concept OPTICAL DISC, is shown in figure 6b).

Guideline 5)

Explanation: Although it is important to represent multidimensionality in order to have a complete classification of the subject field, it can be very confusing to work with several dimensions at once. In our own experience, we found it easiest to work with a single dimension at a time, completing it as exhaustively as possible before moving on to the next dimension. In this way, the confusion and information overload that may come with trying to understand all dimensions simultaneously can be avoided. Also, working with one dimension usually entails working with fewer documents or subject-field experts at any one time than would working with multiple dimensions.

Example: Once we had completed the CD for the concept OPTICAL DISC as fully as possible, we moved on to consider its subordinate concepts. The first dimension we worked on was the dimension based on the characteristic "degree of writability" (i.e., the dimension containing READ-ONLY DISC, WRITE-ONCE DISC, and ERASABLE DISC), and we used CODE's

ISSN: 2324-9773

Bowker, L. (1993). Multidimensional Classification of Concepts for Terminological Purposes. 4th ASIS SIG/CR Classification Research Workshop, 39-56. doi:10.7152/acro.v4i1.12610

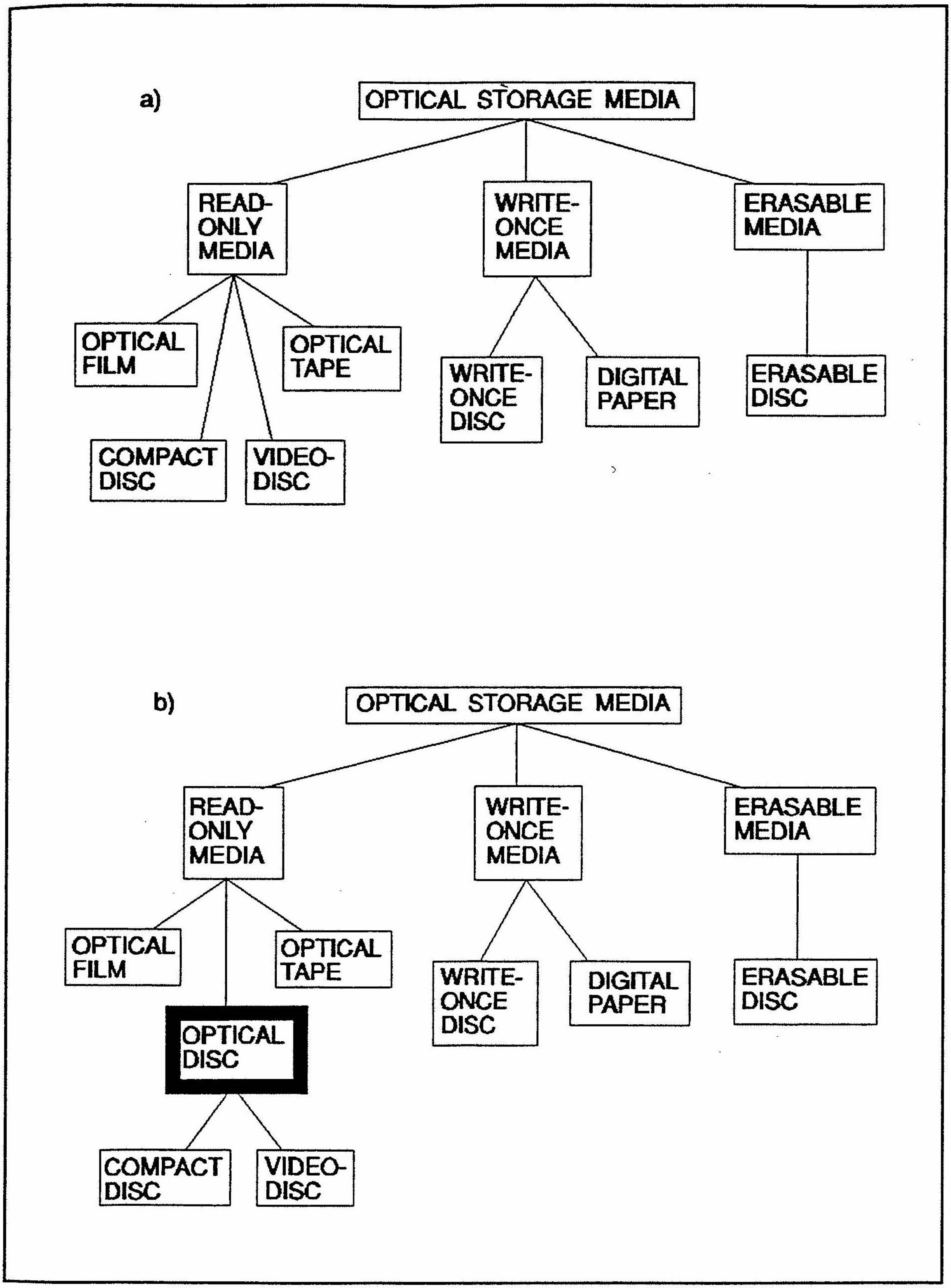

Figure 6. **a) An example of false multidimensionality in a classification of READ-ONLY MEDIA: the concept OPTICAL DISC has been omitted (source: adapted from Chen 1989:5). b) A corrected classification of READ-ONLY MEDIA in which the concept OPTICAL DISC has been included.**

ISSN: 2324-9773

Bowker, L. (1993). Multidimensional Classification of Concepts for Terminological Purposes. 4th ASIS SIG/CR Classification Research Workshop, 39-56. doi:10.7152/acro.v4i1.12610

masking facility to temporarily hide the concepts in the other dimensions. We worked on each of the remaining dimensions one at a time.

Guideline 6)

Explanation: Working with one dimension at a time (see *Guideline 5*) means that terminologists must distinguish between the various dimensions. For practical reasons (e.g. to determine the order in which the dimensions should be worked on, or the amount of time spent on each dimension when there are severe practical constraints on the project) terminologists may want to rank the dimensions. This ranking order might be based on the frequency of occurrence of the terms in the different dimensions, the needs of the users of the terminological descriptions, the relative importance of the various dimensions to current developments in the subject field, etc.

Example: In the early stages of the research, we could not legitimately rank the dimensions of the subfield because we did not know enough about them; therefore, we entered them in an arbitrary order. As we learned more about the subfield, however, we found that certain dimensions appeared more frequently in the literature, and were considered more relevant by our subject-field expert, hence we altered the ranking order accordingly as shown in figure 4.

Guideline 7)

Explanation: Once the dimensions have been ranked, it is necessary to distinguish between them with some form of visible notation. For example, terminologists could assign a different notational symbol, such as a number, to each dimension. Other methods could be to use different coloured or textured lines.

Example: The CODE system makes it possible to distinguish between the different dimensions in a subfield by numbering the k-links (one number per dimension) that are associated with concepts belonging to a dimension. Numbered k-links can be seen in figures 3-5.

Guideline 8)

Explanation: In addition to ranking and distinguishing the dimensions, we found it useful to clearly indicate the characteristic underlying each dimension in a place that is easily accessible to the reader. CODE allows the characteristic name of the characteristic to appear directly on the graph; however, this can make the graph rather cluttered. Another possibility is to insert a short notational symbol, such as a number, on the graph, and then include a legend indicating which characteristic is represented by each notation.

Example: We determined that the concepts READ-ONLY DISC, WRITE-ONCE DISC, and ERASABLE DISC had been classified on the basis of whether the user can write information to the disc (one or more times), or merely retrieve information that has been stored there by the manufacturer. We decided that "degree of writability" would be a good name for this characteristic, and we entered this as a dimensional characteristic for the appropriate concepts. COMPACT DISC and VIDEODISC had been classified according to the "size" of the disc (4.72" vs. 12"), and INDIVIDUAL DISC and REPLICABLE DISC had been classified on the basis of the characteristic "replicability". These characteristic names were also added as dimensional characteristics of the appropriate concepts.

ISSN: 2324-9773

Bowker, L. (1993). Multidimensional Classification of Concepts for Terminological Purposes. 4th ASIS SIG/CR Classification Research Workshop, 39-56. doi:10.7152/acro.v4i1.12610

Guideline 9)

Explanation: We stated earlier (see *Guideline 1*) that terminologists will likely find it advantageous to work with a graphical representation of the concept system from the outset of the project. In order for the graphical representation to be truly helpful, it must be updated and revised throughout the course of the project as terminologists learn more about the subject field.

Example: A partial evolution of the concept system representation of the subfield *optical discs* is clearly illustrated in figures 3-5.

5. CONCLUDING REMARKS

In this paper, we have tried to demonstrate the importance of multidimensional classification to terminology. Knowledge engineering tools now make it possible to move beyond limited unidimensional classifications. The possibility of representing multidimensional knowledge structures opens up interesting areas of research that were not previously very accessible to terminology researchers. For example, multidimensionality has implications in many specific terminology tasks, such as definition construction. When terminologists define a term using the classic intensional definition, they refer to 1) the generic class to which the concept belongs, and 2) the characteristic(s) which differentiate(s) this concept from other members of the same class. In multidimensional representations, concepts can belong to more than one dimension (see figure 2), and thus may have more than one generic concept, and more than one set of coordinate concepts. Now that knowledge engineering tools are available to help terminologists handle the potentially complex phenomenon of multidimensionality, there will hopefully be much more research done in this area in the future.

6. ACKNOWLEDGEMENTS

The terminology research reported in this paper has been supported by the Social Sciences and Humanities Research Council of Canada (SSHRC) and Research Services/Faculty of Arts of the University of Ottawa. Technical Development of the CODE system has been supported principally by the Natural Sciences and Engineering Research Council of Canada (NSERC). Extremely valuable contributions to this research have been made by Dr. Ingrid Meyer and Dr. Douglas Skuce, who are in charge of the COGNITERM and CODE projects at the Artificial Intelligence Lab of the University of Ottawa, Canada, and who co-directed the MA thesis from which this article derives. Various other members of the AI Group at the University of Ottawa have also made valuable contributions to this work: K. Eck, D. Epstein, K. Iisaka, and T. Lethbridge. Professor Juan C. Sager and John McNaught of the Centre for Computational Linguistics at UMIST, Manchester, U.K., also offered constructive comments on this paper.

7. REFERENCES

AUGER, Pierre and ROUSSEAU, Louis-Jean. 1978. *Méthodologie de la recherche terminologique*. Québec: Office de la langue française.

ISSN: 2324-9773

Bowker, L. (1993). Multidimensional Classification of Concepts for Terminological Purposes. 4th ASIS SIG/CR Classification Research Workshop, 39-56. doi:10.7152/acro.v4i1.12610

BOWKER, Lynne. (in press). "Multidimensional Classification of Concepts and Terms." In: WRIGHT, S.E. and BUDIN, G. (eds.): *Handbook for Terminology Management*. Amsterdam/Philadelphia: John Benjamins.

BOWKER, Lynne. 1992. *Guidelines for Handling Multidimensionality in a Terminological Knowledge Base*. M.A. Thesis, University of Ottawa, Canada.

BOWKER, Lynne and MEYER, Ingrid. "Beyond 'Textbook' Concept Systems: Handling Multidimensionality in a New Generation of Term Banks." In: *Proceedings of the Third International Congress on Terminology and Knowledge Engineering (TKE '93)*. Cologne, Germany, 25-27 August 1993.

CHEN, Ching-chih. 1989. *Hypersource on Optical Technologies*. Chicago: American Library Association.

COLE, Wayne, D. 1987. "Terminology: Principles and Methods." *Computers and Translation*. Vol. 2, 77-87.

DUBUC, Robert. 1985. *Manuel pratique de terminologie*. Quebec: Linguatech.

HEIMBURGER, Anneli. 1990. "A Guided Tour to Applications of Optical Disk Technology In the Nordic Countries." *CD-ROM Professional*. July, 31-35.

HUNTER, Eric J. 1988. *Classification Made Simple*. Aldershot, UK: Gower Publishing Company Limited.

MEYER, Ingrid. 1993. "Concept Management for Terminology: a Knowledge Management Approach." In: STREHLOW, R.A. and WRIGHT, S.E. (eds.): *Standardizing Terminology for Better Communication: Practice, Applied Theory and Results*. (Special Technical Publication of the ASTM, No. 1166). Philadelphia: American Society for Testing and Materials, 140-151.

MEYER, Ingrid. 1992. "Knowledge Management for Terminology-Intensive Applications: Needs and Tools." In: PUSTEJOVSKY, J. and BERGLER, S. (eds.): *Lexical Semantics and Knowledge Representation*. Berlin: Springer Verlag, 21-37.

MEYER, Ingrid, BOWKER, Lynne and ECK, Karen. 1992a. "Constructing a Knowledge- Based Term Bank: Fundamentals and Implications." *Proceedings of the International Symposium on Terminology and Documentation in Specialized Communication*. (Hull, Canada, October 1991). Ottawa: Minister of Supply and Services, Canada, 232-256.

MEYER, Ingrid, BOWKER, Lynne and ECK, Karen. 1992b. "COGNITERM: An Experiment in Building a Knowledge-Based Term Bank." *Proceedings of the Fifth EURALEX International Congress (EURALEX '92)*. Tampere, Finland: Tampereen Yliopisto, 159-172.

MEYER, Ingrid, SKUCE, Douglas, BOWKER, Lynne and ECK, Karen. 1992. "Towards a New Generation of Terminological Resources: An Experiment in Building a Terminological Knowledge Base." *Proceedings of the 14th International Conference on Computational Linguistics (COLING '92)*, Vol. III. Nantes: ICCL, 956-960.

PICHT, Heribert and DRASKAU, Jennifer. 1985. *Terminology: An Introduction*. Guildford: University of Surrey.

RONDEAU, Guy. 1984. *Introduction à la terminologie* (Deuxième édition). Québec: Gaëtan Morin Éditeur.

SAGER, Juan C. 1990. *A Practical Course in Terminology Processing*. Amsterdam/Philadelphia: John Benjamins Publishing Company.

ISSN: 2324-9773

Bowker, L. (1993). Multidimensional Classification of Concepts for Terminological Purposes. 4th ASIS SIG/CR Classification Research Workshop, 39-56. doi:10.7152/acro.v4i1.12610

SKUCE, Douglas and MEYER, Ingrid. 1991. "Terminology and Knowledge Engineering: Exploring a Symbiotic Relationship." *Proceedings of the 6th Banff Knowledge Acquisition for Knowledge-Based Systems Workshop*. Vol. 2, 29-1 - 29-21.

SKUCE, Douglas and MEYER, Ingrid. 1990. "Computer-Assisted Concept Analysis: An Essential Component of a Terminologist's Workstation." *Proceedings of the Second International Conference on Terminology and Knowledge Engineering Applications*. Frankfurt: INDEKS Verlag, 187-199.

ISSN: 2324-9773

Bowker, L. (1993). Multidimensional Classification of Concepts for Terminological Purposes. 4th ASIS SIG/CR Classification Research Workshop, 39-56. doi:10.7152/acro.v4i1.12610

ISSN: 2324-9773