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Computerized Deep Structure Indexing System – A Critical Appraisal

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In 1964, Ranganathan manifested a novel approach to alphabetic subject indexing based on his idea of Facet Analysis in conjunction with the General Theory of Classification. Since then, research carried out at the Documentation Research and Training Centre, Bangalore, has led to three distinct but interrelated contributions – a General Theory of Subject Indexing Language (SIL); an indexing language called Postulate-based Permuted Subject Indexing (POPSI), abstracted from the General Theory of SIL; and a faceted hierarchic scheme of terms with vocabulary control features, called Classaurus, also designed on the basis of the General Theory of SIL. Attempts were also carried out to use modern technology such as computers, to enforce a rigorous definition on the system. The most recent version of computerised POPSI is known as Deep Structure Indexing System (DSIS). Following the publication of the FID/CR Report entitled "Computerized Deep Structure Indexing System", a research project entitled 'Applicability and efficiency of deep structure based Subject Indexing Languages (SILs): PRECIS vs. DSIS' was undertaken at DLIS, Loughborough University, in 1986. Part of this project has been to write a software for DSIS, using a microcomputer. A representative sample of 600 documents (equally halved between macro- and micro-documents), chosen from three different social science subject fields, have been used as the test data. This paper presents some of the drawbacks of the system which surfaced during the study. Although, no remedial measures being proposed at the moment, it is hoped that future modifications, if any, will try to alleviate these bottlenecks. (Authors)

1. Introduction

One of the most significant contributions of Dr. S.R. Ranganathan is his technique of Facet Analysis and the associated Theory of Analytico-synthetic Classification based on postulates and principles. The procedure was first laid down by Ranganathan (1) in 1944 and was subsequently incorporated in the skeletal form of five Fundamental Categories in the 4th edition of his Colon Classification published in 1952. Since then, the technique of Facet Analysis has paved the way for the development of faceted classification schemes and new indexing languages in India and elsewhere. Devadason (2) has provided a brief summary of its recent applications in various domains of information handling. In 1964, Ranganathan (3) demonstrated a new line of thinking regarding verbal subject indexing based on Facet Analysis according to his General Theory of Classification. In India, research in this new line of thinking has led to three distinct but interrelated contributions (4, p. 11) as follows:
(1) A General Theory of Subject Indexing Language (SIL) developed through logical abstraction of the structures of outstanding SILs such as, Cutter, Kaiser, Dewey, and Ranganathan (5, p. 73–88; 6; 7).
(2) The Postulate-based Permuted Subject Indexing (POPSI) language developed through logical interpretation of the Deep Structure (DS) of SIL forming part of the General Theory of SIL (5; 6; 8; 9).
(3) The Classaurus, a faceted hierarchic scheme of terms with vocabulary control features, designed on the basis of the General Theory of SIL (4, p. 17; 10; 11; 12).

Since the first exposition of POPSI in 1969 (13), several modifications have been carried out by Bhattacharyya and his colleagues (7; 8; 9; 14; 15; 16) at DRTC (Documentation Research and Training Centre), Bangalore, India. More recent developments of POPSI have been reported as part of a more versatile subject indexing system known as Deep Structure Indexing System[1] (DSIS) (18). A detailed account of the system in all its ramifications could be found in Devadason's voluminous doctoral dissertation entitled "Computèr based systems for generating different types of subject indexes and alphabetical classaurus based on the 'Deep Structure' of Subject Indexing Languages" (19). For wider dissemination of the findings of this relatively inaccessible thesis, FID/CR asked Devadason to write a research paper which was subsequently published as an FID/CR report entitled "Computerized Deep Structure Indexing System" (20).

Following Dahlberg's (21) invitation to "read and see" and find out "whether Devadason's solution could once [sic] perhaps, in future, replace PRECIS, as it is easier to learn and to computerise, or consider what place it may receive in the long run for the optimal indexing system", a research project entitled "Applicability and efficiency of deep structure based Subject Indexing Languages (SILs): PRECIS vs. DSIS" was undertaken at the Department of Library and Information Studies, Loughborough University of Technology, Loughborough, UK, in 1986. Part of this project was to create an *index string generator*[2] for DSIS which could be used simultaneously for automatic generation of an online Classaurus, the vocabulary control tool used for this system. The program suite has been written in CBASIC (an advanced version of BASIC by Digital Research, suitable for string handling) and run on a Comart microcomputer system. What follows, is a critical evaluation of DSIS – highlighting its failures, rather than its achievements.

2. Materials and Methods

Three sets of two hundred documents each, equally divided into macro and micro, respectively related to the subject fields of adult education, information retrieval and labour economics, were recorded on 'Input Record Sheets' from secondary sources. In the case of macro documents such as, books, monographs, etc. the only secondary source being used was the *British National Bibliography (BNB)* (London: The British Library,

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1951–). For the micro documents such as, journal articles, research papers, etc. sources were respectively *Current Index to Journals in Education* (Phoenix, Arizona, USA: Oryx Press, 1969–), *Library and Information Science Abstracts* (London: Library Association, 1950–), and *Journal of Economic Literature* (Nashville, Arizona, USA: American Economic Association, 1963–) for the above three fields. The samples were drawn at random from the above named sources, published within 1981 to 1985. DSIS input strings for each of the six hundred items were constructed based on the steps and procedures recommended in the FID/CR report (20, p. 9–24). The following sub-section gives a summary description of the system[3].

2.1 DSIS and its Methodology

DSIS is based on: 1) a set of postulated Elementary Categories (ECs) of the elements fit to form components of names of subjects; 2) a set of syntax rules with reference to the ECs; 3) a vocabulary control tool such as the Classaurus; 4) a set of indicator digits to denote the ECs and their subdivisions; and 5) a set of codes to denote a few of the decisions of the indexer, in order to generate by computer manipulation, different types of subject indexes (23, p. 87).

2.1.1 Postulates of ECs

The DS of SIL postulates that the component ideas in a subject statement can be a manifestation of any one of the ECs: Discipline (D), Entity (E), Property (P), Action (A), and a special component called Modifier (m). If a component term represents manifestations of more than one EC then it is a Composite Term. It should be factored into two or more constituent terms and each one of them should be identified as belonging to one or the other of the ECs. The Composite Term is considered in DSIS as a synonymous term to the combination of the factored constituent terms, e.g., Library management = Library (E) + Management (A). Manifestations of each of the ECs may have subdivisions: Species/Type, Part and sometimes Constituent. A Species/Type does not disturb the conceptual wholeness of the manifestation to which it is a Species/Type. A Part is a non-whole of the manifestation to which it is a part. A Constituent is an ultimate part with its own individuality. For example, in the case of 'Motor car', 'Racing car' is a Species/Type; 'Engine', 'Door', 'Seat' are Parts; 'Steel', 'Glass', 'Rubber' are Constituents.

In relation to the manifestation of anyone of the ECs, 'Modifier' refers to an idea used or intended to be used to qualify (differentiate, speciate) the manifestation of any one of the ECs (viz., Discipline, Entity, Property, and Action) without disturbing the conceptual wholeness of the latter. For example, 'Skilled' in 'Skilled personnel'; 'Vocational' in 'Vocational education'. A Modifier generally creates a Species/Type of the modifyee (focus). DSIS prescribes two main types of Modifiers: Common Modifiers like Form, Time, Environment and Place, and Special Modifiers based on Discipline or Entity or Action or Property. Depending on the structure of the 'Modified Term', Modifiers could be further grouped into two types:

1) *Modifier of Kind 1*, that which requires the insertion of auxiliary/function words between the modifyee term and its modifier term forming a Complex Term. For example, 'Hospitals *for* children' which is a type of 'Hospital'; and
2) *Modifier of Kind* 2, that which does not require the insertion of any auxiliary/function words (in between), but automatically forms an acceptable Compound Term. For example, 'Stainless steel' which is a type of 'Steel'.

2.1.2 Rules of Syntax

In DSIS the rules of syntax give rise to the following syntactical structure to a subject statement formulated according to DS of SIL:

"DISCIPLINE followed by ENTITY which is followed by PROPERTY and/or ACTION. PROPERTY and/or ACTION may be further followed by PROPERTY and/or ACTION as the case may be, followed by COMMON MODIFIERS. The SPECIFIERS/TYPES and/or MODIFIERS and/or PARTS and/or CONSTITUENTS, for each of the ECs follow immediately adjacent to the manifestation to which they are respectively SPECIES/TYPES or MODIFIERS or PARTS or CONSTITUENTS without the manifestation of any other EC intervening" (20, p. 5).

A Modifier follows immediately the manifestation in relation to which it is a Modifier. This principle implies that when there is more than one Modifier to the same manifestation, any one valid sequence of them in terms of their representation in the natural language is acceptable. But it is advisable also to follow Ranganathan's Principles for Facet Sequence such as the Wall-Picture Principle and its corollaries in deciding the sequence of Modifiers. The rules of syntax give rise to a context-dependent sequence of the components in the subject statement.

2.1.3 Indicators of DS

The following numeric codes have been used in DSIS to indicate the manifestations of the different ECs, their subdivisions and modifiers of different kinds:

Common Modifiers	*Elementary Categories*
0 Form Modifier	9 Discipline
2 Time Modifier	8 Entity
3 Environment Modifier	.2 Property
4 Place Modifier	.1 Action

Subdivisons/Divisors

.3 Constituent
.4 Part
.5 Modifier of Kind 1 including Phase Relation Modifier
.6 Species/Type, including those created by Modifier of Kind 2.

In a subject statement the indicators precede the components to which they are indicators.

2.1.4 Formulation of Subject Statement

To aid in writing out an indicative formulation that summarises in its message 'what a particular body of information is about' the title of the document is being supplemented by additional terms selected from feature headings (in the case of macro documents), abstracts (for micro documents), etc. Two examples are provided here to make this point intelligible:

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1) Clarification of the Original Title basing on the Feature Headings

[Cross, Michael. *Towards the flexible craftsman*. London: Technological Change Centre, c1985]
BNB Feature Heading: Engineering industries. Personnel. Maintenance skills. Effects of technological change.
BNB Dewey Decimal Classification broad class no.: 331 – Labour economics.
Expressive Title: In labour economics, effects of technological change on the maintenance skills of personnel in engineering industries.

2) Inclusion of New Terms from the Abstract

[Berman, Sanford. Beyond the pale: subject access to Judaica. *Tech. Serv. Quart.* 2 (1984) No. 1/2, p. 173–189]
Abstract: Discusses Library of Congress shortcomings in the subject treatment of Jewish materials suggesting that it falls short of the goals of access and equity. Outlines several aspects of the vocabulary problem and its application which has been illustrated with real cases. Suggests 2 ways of improving subject cataloguing.
Expressive Title: In information retrieval, treatment of Jewish materials in Library of Congress Subject Headings scheme.

The *BNB Subject Authority Fiche* (London: The British Library, September 1985) is being used to 'modulate' the name of subject by augmenting it by interpolating and/or extrapolating as the case may be, the successive superordinates of each EC manifestation, by finding out "of which it is a Species/Type or Part or Constituent". The same authority file has been used to 'standardize' the component terms in the name of a subject. Reason behind this decision being to keep terminological variations to a minimum level in between the DSIS and PRECIS index. Of course, care has been taken to avoid the use of certain terms like 'Information retrieval systems using computer systems', which PRECIS uses as a single concept. But for DSIS input string writing purpose this has been changed into its acceptable compound form in the English language as 'Computerised information retrieval systems' and rendered as,

Information retrieval systems. Computerised information retrieval systems

2.1.5 Coding of the Name of Subject

The following processing codes[4] are used in DSIS for computer manipulation: 1) $0 – Lead Term; 2) $1 – Context Term; 3) <> – enclosed within, is a Complex Term; 4) $2 – Lead in Permuted Cross Reference (PCR) Entry arising out of Complex Term; 5) $* (function word identifier), / (function word delimiter) – enclosed within, is a function word(s); 5) $9 – neither Lead nor Context; and 7) $3 – used with Modifiers of Kind 2 to create Compound Terms.

2.1.6 Subject Index Entry

There follows an example of a possible input string and resultant 'Unicomponent term Lead Heading with Full Context Heading' POPSI index entries to the name of subject 'In labour economics, effect of technolgical change on the maintenance skills of personnel in engineering industries'.

$9 Labour economics 8 $9 Industries 8.6 $0$3 Engineering 8.4 $0$1 Personnel 8.2 $9 Skills 8.2.6 $0$1 ⟨Maintenance skills 8.2.5 $* (effects of)/$2 Technological change⟩

Index entries

Engineering Industries → *Lead Heading*
Labour economics 8 Industries 8.6 Engineering industries 8.4 Personnel 8.2 Skills 8.2.6 Maintenance skills 8.2.5 (effects of) Technological Change → *Context Heading*
B001 → *Location/Address*

Personnel
Labour economics 8 Industries 8.6 Engineering industries 8.4 Personnel 8.2 Skills 8.2.6 Maintenance skills 8.2.5 (effects of) Technological Change
B001

Maintenance skills (effects of) Technological change
Labour economics 8 Industries 8.6 Engineering industries 8.4 Personnel 8.2 Skills 8.2.6 Maintenance skills 8.2.5 (effects of) Technological Change
B001

Technological change/Maintenance skills (effects of) → *PCR Entry*

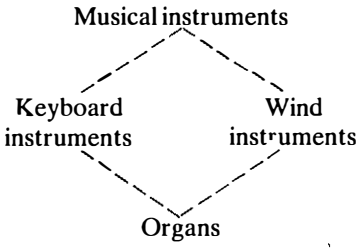
Staff = Personnel → *CR Entry*

3. Problems

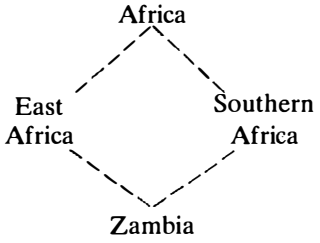
This section presents a firsthand description of the various problems which have surfaced during the generation of the DSIS index.

3.1 Polyhierarchical Relationships

It is not unusal for concepts to belong, on equally logical grounds, to more than one class at a time. The relation between the concept and its two or more superordinate concepts is said to be polyhierarchical (24, p. 10–11), e.g.



The concept 'Organs' in the example above is assigned to a subordinate position on the basis of its common generic relationship to each of two broader concepts. This phenomenon may apply also to hierarchical whole-part relationships such as,



In this example, 'Zambia' as a country (part) belongs geographically to both the regions (wholes), viz., East Africa and Southern Africa. In other cases these polyhierarchical links may be based upon logically different relationships. In the following example:

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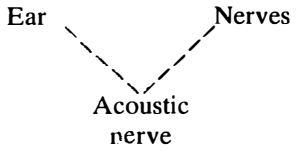


the link between 'Ear' and 'Acoustic nerve' is based on the hierarchical whole-part relationship, and that between 'Nerves' and 'Acoustic nerve' is based on the generic relationship.

Devadason (12, p. 16) has accepted the existence of polyhierarchies in the Classaurus when he says "like a thesaurus, any term is permitted to appear in as many hierarchies as may be appropriate". His suggestion on the problem is "If it is identified that the particular component term being chosen to form the Context is polyhierarchic (ascertained from the alphabetical chain index to the concerned Classaurus), then the successive superordinate terms to it that resolve the homonym should also be selected to form the Context" (20, p. 17). This will help the indexer to solve the problem envisaged in example 3 above, but not the problems in examples 1 and 2. Because, in these two cases the term in question (viz., 'Organs', 'Zambia') is linked to the top superordinate term through two different intermediate superordinate terms. Though DSIS follows a 'tree structure' in the coding of input strings, entries are written in a horizontal linear format. It is unsuitable for accommodation of multiple hierarchies in a meaningful way. The only viable solution may be to write separate strings such as,

Music 8 Musical instruments 8.6 Keyboard instruments 8.6 Organs

and,

Music 8 Musical instruments 8.6 Wind instruments 8.6 Organs

But the "use of multiple input strings in fact opposes one of the major advantages of string indexing, that of many index entries from a small amount of input" (22, p. 72). Another alternative may be to have a *preferential placement* such as classification schemes propose. For example, Universal Decimal Classification (25, p. 140–141) places 'Organs' under the class '786 Keyboard instruments' and not under '788 Wind, brass and wood-wind instruments'. This sort of practice presumes that the users always express their information needs consistently, which, in fact, they do not. The whole idea is the product of the myth which "has come to be perpetuated among librarians and information scientists that they were expected to communicate with human beings capable of rational exposition of their information needs" (26, p. 28). Even then, this will be nothing but repetition of the works of the classificationist, thus sacrificing the users' convenience for the benefit of the indexer.

3.2 Choice of Lead Term

So far as the selection of the Lead Term in an index is concerned, it is well known that significant or sought terms are usually led, but not diffuse or heavily-used terms. Despite the fact that it is very difficult to ascertain which terms are significant and which are not, general decisions concerning Leads are to be formulated within an organisation and recorded as policy statements. For example, very generic Entity terms such as, man, animals, plants, etc., very common Action terms such as, evaluation, analysis, determination, etc., very common Property terms such as, efficiency, property, effectiveness, etc., and terms denoting Common Modifiers like, Form, Place, Time, etc., need not be necessarily selected to form Lead Terms. Policies of this kind may vary from one organisation to another depending on the purpose of the subject index – the subject area concerned, the material being indexed and the community of users served by the index. Whether or not a term should appear in the Lead is to be determined entirely by the indexer, not by the system or the computer (27, p. 24). DSIS should not be an exception to this. But at least in one occasion the indexer is compelled to make a term Lead even if he does not want to do so. In DSIS, PCR entries (See sec. 2.1.6) are formed by cyclic permutation of constituents in a Complex Term, so that significant constituent terms in it also form the Lead. For instance, a string like

$9 Leather technology 8 $1 Leather chemicals and auxiliaries 8.6 $1 Soaking material 8.6 $0$1 Soak liquor 8.2 $0$1 Protein content 8.2.1 $0$1 ⟨Determination 8.1.5 $* (using)/$2 Spectro photometry⟩

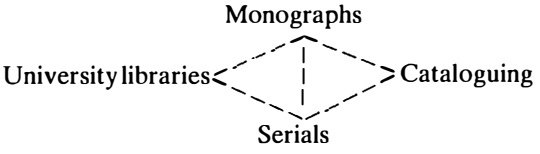
would generate the following uni-component term Lead Headings such as,

Soak liquor
Protein content
Determination (using) Spectro photometry
Spectro photometry/Determination (using)

Now if the indexer decides not to have a Lead on 'Determination' but only on 'Spectro photometry', thinking that the former is too general a term to have a place in the index, he is in trouble. Because there would not be any entry having the standard rendering of the Complex Term as Lead, under which other sections such as the Context Heading section and Location section appear. Therefore, the entry under 'Spectro photometry' (which is a PCR entry, having neither the Context Heading section nor the Location section) virtually leads to a blank and becomes meaningless. To have a Lead Heading under the second or successive significant constituents of a Complex Term one must have a Lead on the first constituent term irrespective of its status. This limits choice by the indexer.

3.3 Coordinate Relationship

Many documents deal with concepts which share mutual or coordinate relationship with some other component in the input string. This coordinate concept calls for the addition of a second dimension to the linear or one-to-one structure among concepts in the input string. For example, a subject like, 'Cataloguing of monographs and serials in university libraries' could be diagrammatically represented as,



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In describing their methodology of facet structuring of subjects for the identification of non-hierarchical associative relationships[5] (NHR) among ideas forming components of subjects, Neelameghan and Maitra (29, p. 9) have also confirmed that "every type of NHR can be represented by one or other of the following relations – facet relation, speciator relation, phase relation and *coordinate relation* – in the facet analysed representation of subjects" (authors' italics). The 'coordinate relation' is defined as the "relation between two or more ideas in one and the same array, derived from a broader or superordinate idea on the basis of a single characteristic for the division". POPSI (as well as DSIS) prescribes that "what is non-hierarchically related to what, will be revealed by the subject-propositions themselves through their alphabetical arrangement. . . . for, in this process two terms are said to be related because they have occurred as related in the sources of information" (5, p. 101). Therefore, all the associative relationships (i.e., NHRs), including the coordinate relationship, are to be revealed through the index entry itself, not through any RT-type (or, "See also") cross-references from the thesaurus (in fact, Classaurus does not include them at all). So it is obvious that there would be some provision for the treatment of such coordinate terms in the system.

But DSIS hardly gives any consideration to documents dealing with such coordinate concepts, except in 'special situations' where "the conjunction 'and' may also be used in a Complex Term to form a multifocal component" (20, p. 15), such as:

Information retrieval 8.1.5 (using) Microcomputers 8.1.5 (and) Interactive videos

According to Devadason "multifocal or multi-theme documents would require separate names of subject for each theme". So far as multi-theme documents are concerned this treatment is satisfactory, but may not be feasible for documents dealing with coordinate concepts. The failure lies in the added work required of the indexer and of the index string generator. Besides the increase in the amount of input work, on several occasions it may lead to loss of intelligibility. For example, if a subject like 'Integration of administrative and technical skills of senior library personnel in university libraries' is coded separately as,

University libraries 8.4 Senior library personnel 8.2 Administrative skills 8.2.1 Integration

and

University libraries 8.4 Senior library personnel 8.2 Technical skills 8.2.1 Integration

then the last term in both the strings become misleading, since the concept 'Integration' logically refers to both 'Administrative skills' and 'Technical skills' as a whole unit, not to each individual preceding term separately. Austin designates them as 'Bound coordinate concepts' (27, p. 97) and has made separate provision to deal with them.

3.4 Types of POPSI Entries

Devadason (20, p. 32) has claimed that four major types of POPSI entries could be formed by the way the Lead Headings and Context Headings are formed in DSIS, viz.,

1) Uni component term Lead Heading with Full Context Heading;
2) Uni component term Lead Heading with Short Context Heading;
3) Lead Heading with Upper Link Specifiers and Full Context Heading; and
4) Lead Heading with Upper Link Specifiers and Short Context Heading.

Examples of subject index entries of types 1, 2, and 3 were provided in Exhibits 4, 5, and 6, respectively (20, pp. 39–41). However, if one takes a closerlook into the portion of subject index entries in Exhibit-5, then it becomes evident that certain Lead Headings look dubious and out of context, e.g.,

Chemical property
Leather technology 8 Leather 8.2 Hydrophobicity 8.2.5 (influenced by) Organo silicon compounds

In the above example, certainly the user will find it difficult to establish the proper context of the Lead Heading 'Chemical property', as to whether it is associated with 'Leather' or 'Organo silicon compounds'. Of course, this is a very simple example and possibly meant for a subject expert who is knowledgable enough to comprehend the actual meaning of the subject. But there could be hundreds of subjects, especially in micro documents dealing with disciplines such as, chemistry, biochemistry, genetics, etc., where the index might need to display various rounds of Entities and Actions in a single index entry with their respective Properties (mostly as Modifiers, Parts and Constituents), eventually leading into much more confusions. There might even be occasions when the subject expert may find it difficult to ascertain the context-dependency of such Lead Headings.

Similarly, in the case of type 4, there could be occasions when certain entries might carry redundant information in them. For example, let us consider the following name of subject 'In leather technology, acrylic surface finsihing of leather'. This would be represented as per DS of SIL as:

Leather technology 8 Leather 8.1 Finishing 8.1.6 Surface finishing 8.1.6 Acrylic surface finishing

Selecting the last component term falling in each of the ECs would give rise to the following 'Short Context Heading':

Leather technology 8 Leather 8.1 Acrylic surface finishing

The component terms selected to form the Short Context Heading are used to form Upper Link Specifiers. The sequence of component terms in the Lead Heading containing Upper Link Specifiers taken from left to right is the reverse of the sequence of component terms in the Short Context Heading. Accordingly, we would get the following index entries:

Leather, Leather technology
Leather technology 8 Leather 8.1 Acrylic surface finishing
Acrylic surface finishing, Leather, Leather technology
Leather technology 8 Leather 8.1 Acrylic surface finishing

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The last entry certainly brings into an amount of redundant information, which could be described as the information which the searcher already has. Because the Context Heading merely repeats the same information conveyed by the Lead Heading, the difference being only in their format and sequence. According to Craven (22, p. 9), "Two things which waste searcher effort and so decrease efficiency are *redundant* information and irrelevant information" (authors' italics).

3.5 Modifiers

In Section 2.1.1 above, we have seen that depending on the structure of the modified term Modifiers could be classified into two types – Modifiers of Kind 1 and 2, respectively. It would be useful if we take a closer look into the nature of these two types of Modifier and their implications for the whole indexing system.

3.5.1 Modifier of Kind 1

In DSIS Complex Terms formed using auxiliary/function words are also used to represent Complex Subjects. A "Subject formed by coupling two or more subjects expounding, or on the basis of, some relation between them" constitutes a Complex Subject (30, p. 85). Each component in such a subject is called a 'phase' and the mutual relationship between the phases of a Complex Subject is called 'phase relation'. Ranganathan introduced five kinds of phase relation – General, Bias, Comparison, Difference and Influence. In addition to the above five, Bhattacharyya (8, p. 18) prescribed two more, viz., Similarity and Application. Neelameghan and Gopinath (31; 32; 33) have carried out detailed studies of phase relations. But "Complex Subjects formed by phase relations are generally narrower than the subject represented by the first phase" seems to be over generalisation (20, p. 4). For example, 'Information systems *biased to* industry' is narrower than 'Information systems' and could be considered as a Species/Type, but it is hard to agree that 'Pre-coordinate indexing systems *compared with* post-coordinate indexing systems' is narrower than 'Pre-coordinate indexing systems'. Moreover, though Complex Subjects formed by phase relation such as, 'Information systems *biased to* industry' is later amenable to form 'Fused Subjects' represented by Compound Term/terms like 'Industrial information systems', it is difficult to foresee any such development in technical terminology (at least in the near future) which can change Complex Subjects such as 'Pre-coordinate indexing systems *compared with* post-coordinate indexing systems' into an acceptable Compound Term/terms. It seems to be too much of an attempt to fit every case into a single straight jacket.

Further, it is being proposed that "Generally it is not necessary to 'modulate' Modifier of Kind 1 forming Complex Term. But if the Modifier of Kind 1 term occurs in the Classaurus for the concerned subject area as a manifestation of any of the ECs: Entity, Property, or Action (and not just a Modifier alone), then it may be worthwhile to include its broader terms also" (20, p. 10). But how? No suggestions have been put forward as to the manner in which such Modifier of Kind 1 terms are to be modulated. Certainly it cannot be incorporated within the Complex Term block enclosed within the angular brackets. For example, given that a section of the Entity schedule in the Classaurus for 'Library and information science' is,

Information systems
. Information processing systems
. . Data processing systems
. . . Computer systems
. . . . Expert systems

and the subject to be indexed is 'Evaluation of medical information retrieval using expert systems'. This could be analysed and formalised as follows:

(Discipline) Library and information science, (Entity) Information, (Type of Entity) Medical information, (Action) Retrieval (Entity based Modifier) (using) Expert systems, (Action on Action) Evaluation

Now, if we modulate Modifier of Kind 1 term by augmenting it by interpolating the successive superordinates, then we would get:

(D) Library and information science, (E) Information, (Type of E) Medical information, (A) Retrieval (m1) (using) Information systems, (Type of m1) Information processing systems, (Type of m1) Data processing systems, (Type of m1) Computer systems, (Type of m1) Expert systems, (A on A) Evaluation
[m1 = Modifier of Kind 1]

After replacing auxiliary words denoting the different manifestations with appropriate indicators, the resulting name of subject would be:

Library and information science 8 Information 8.6 Medical information 8.1 Retrieval 8.1.5 (using) Information systems 8.1.6 Information processing systems 8.1.6 Data processing systems 8.1.6 Computer systems 8.1.6 Expert systems 8.1.1 Evaluation

So far, so good. But if one considers the practicalities of searching such renderings, one might conclude that "Introduction of . . . superordinate links in a subject string where they are superfluous leads to confusion among information system users and therefore possible misinterpretation of the subject strings" (34, p. 12). As in this case, by the time the user reaches 'Evaluation' he could easily have lost the link between 'Retrieval' (modifyee or focus) and 'Expert systems' (Modifier). He may by now be thinking that it is an 'Evaluation of expert systems for . . . (something)', rather than 'Evaluation of medical information retrieval using expert systems'. This seems to be the most serious drawback of modulating Modifier of Kind 1 terms forming part of the Complex Term, even if it appears in the Classaurus as a manifestation of one of the Elementary Categories. Of course, the same could be said to be true for the whole system as it proposes to modulate the subject statement by interpolating and/or extrapolating as the case may be, the successive superordinates of each EC manifestation by finding out of which it is a Species/Type or Part or Constituent. This practice certainly leads to an enormous increase in the number of terms in a subject string. While users' surveys have found out that "Subject strings with eight or more component terms present difficulties in interpretation" (34, p. 12).

3.5.2 Modifier of Kind 2

Our next consideration is the Modifier of Kind 2, which

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creates a Species/Type of the modifyee (focus). For example, a Compound Term like 'Fee-based user-friendly online information systems' would be input as,

Information systems $3 Online $3 User-friendly $3 Fee-based

and rendered as

Information systems. Online information systems. User-friendly online information systems. Fee-based user-friendly online information systems

The hierarchy then is

Information systems
. Online information systems
.. User-friendly online information systems
... Fee-based user-friendly online information systems

The corresponding Classaurus entry will be

Information systems
. Fee-based information systems
. Online information systems
.. User-friendly online information systems
... Fee-based user-friendly online information systems
. User-friendly information systems

One can see that 'Fee-based user-friendly online information systems' has not been repeated under either 'Fee-based information systems' or 'User-friendly information systems'. As a result when one searches for 'Fee-based information systems' or 'User-friendly information systems', he will not find 'Fee-based user-friendly online information systems'. No one can deny that someone interested in either of these two subjects would find it useful to consult the document dealing with the subject mentioned above. Due to alphabetic adjacency, he might find it in the alphabetic index part close to the entry 'Fee-based information systems', but not to the entry 'User-friendly information systems'. Because the latter will be far down in the alphabetic order, especially in a large file such as *LISA* (*Library and Information Science Abstracts*).

Another interesting case may be worth discussing at this juncture. For example, there are two documents having their names of subjects as: 1) Raleigh men's bicycle and 2) Men's Raleigh bicycle. Everyone would agree that both of these represent the same subject and are acceptable in terms of their representation in English language. The reason behind the variation in their wording is nothing but the result of their respective authors' preferences. Now according to DSIS both of them will give rise to different hierarchies and consequently be filed under different headings in the alphabetic order:

1) Bicycle $3 Men's $3 Raleigh and Bicycle
. Men's bicycle
.. Raleigh men's bicycle

2) Bicycle $3 Raleigh $3 Men's and Bicycle
. Raleigh bicycle
.. Men's Raleigh bicycle

Anyone searching under either 'Raleigh men's bicycle' or 'Men's Raleigh bicycle' is definitely going to miss the other, resulting into loss of relevant information. This considerably reduces the 'recall value' of the system and raises doubt about the efficacy with which the Principles for Facet Sequence could be applied to determine the sequence of Modifiers in a Compound Term.

Bhattacharyya (9, p. 251) suggests that "there will always be the need to permutation in such a situation". Though he has not made it clear whether these permutations are to be entered in the index in the form of subject index entries with the permuted terms as Lead Headings and Context Headings, or as Cross Reference entries parallel to the type used for controlling naturally occurring synonyms, quasi-synonyms, etc. Similarly, Devadason (17, p. 3) suggests that "If by chance, the alphabetical adjacency technique does not work, then permuted (inverted) renderings of Compound Terms may have to be included in the alphabetical index to the Classaurus". But it is difficult to visualize how this is going to help, since Classaurus is necessarily the indexer's tool and all such permutations (invertions) are to be reflected in the index entries also. The outcome would be obviously more than one input string for a single subject statement, which is self-defeating for the purpose of string indexing. To support his use of Ranganathan's classificatory principles as the most useful aid to the construction of Classaurus, Devadason (12, p. 25) has quoted Fugmann: "The ease with which newly emerging terms and relations between terms can, purely physically be entered into a thesaurus, has seduced documentalists into making excessive use of this possibility. This has sometimes led to an entire break down of prominent and initially promising thesauri". But the above practice, in fact, goes against Fugmann. Total reliance on the natural language order (of the author) and the Wall-Picture Principle would give birth to multiple unconnected hierarchies and resulting loss of collocation among index entries. As a result, the index would fail to perform one of the three functions of an index entry, viz., the 'relating function', which is being defined as "the location of entries for topics related to the one being sought" (35, p. 19). It is true that "Indexing as a process in which we are involved, is document oriented indexing" and "The relation between index terms should be based on (are brought out by) the individual document being indexed and on the subject (area) treated in the document" (17, p. 2). But it is also true that it is the information (idea) contained in the document which we are interested at the end, not the document *per se*. The above situation makes it apparent that certain additional procedures must be introduced to standardize and control the use of authors' description of subjects for the indexing purpose. Our aim should be to satisfy 'Every user (reader) his/her information (book)' supplemented by 'Every information (book) its user (reader)'.

3.6 Inadequacy of EC Indicators

The following sub-sections reveal some instances when it seems that there is not enough provision in DSIS to deal with all possible types of component ideas in the name of a subject.

3.6.1 Case for Tool/Instrument/Direct Agent

In DSIS the rules of syntax (See sec. 2.1.2) give rise to a context-dependent sequence of the components in the name of subject in conformity with Ranganathan's Principles for Facet Sequence – the Wall-Picture Principle

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and its derivatives such as the Actand-Action-Actor-Tool Principle.

The 'Actand-Action-Actor-Tool Principle' has been defined by Ranganathan (30, p. 428) as, "If in a subject, facet B denotes action on facet A by facet C, with facet D as the tool, then the four facets should be arranged in the sequence A, B, C, D". For example, we have a name of a subject in our hand: 'In education, curriculums for in-service training of semi-skilled workers in polytechnics'. Here the Action is 'In-service training'; the Actand is 'Semi-skilled worker(s)'; the Actor is absent, but implied (maybe teachers or tutors); and the Tool (instrument or agent) is 'Curriculum(s)'. The sequence between 'Polytechnics' and 'Semi-skilled workers' is determined by the 'Whole-Organ Principle', which says "If, in a subject, facet "B" is an organ of facet "A", then A should precede B" (30, p. 427). Therefore, we shall have 'Polytechnics. Semi-skilled workers', the latter being an organ or part of the former. Of course, everything will be preceded by the Discipline term 'Education'. Therefore, when expressed in transformed skeleton form, we shall have 'Education. Polytechnics. Semi-skilled workers. In-service training. Curriculums'. This result can also be achieved by the repeated application of the Wall-Picture Principle. The above name of subject could be analysed and formalised according to DSIS as:

(Discipline) Education, (Entity) Polytechnics, (Part of Entity) Semi-skilled workers, (Action on Part of Entity) In-service training, (Tool or Instrument or Agent) Curriculums

After applying EC indicators we get:

Education 8 Polytechnics 8.4 Semi-skilled workers 8.1 In-service training [ ] Curriculums

If one takes a closer look he will find that in both the expressions above the term 'Curriculums' has not been coded following DSIS procedures. Because the system does not provide any suitable EC for it in the above name of subject. The nearest possible solution may be to treat it as a Special Modifier. But again, it does not fall within the circumference of the structure of the 'Modified Term' deemed to form either Modifier of Kind 1 or Modifier of Kind 2. The former needs the insertion of suitable auxiliary/function words (in between) to form an acceptable natural language title-like phrase, which is not possible in this case; while the latter requires to form an acceptable Compound Term automatically, which it also fails to be. Let us see what Devadason has to say in this respect. In his opinion, the above document says very little about 'Polytechnics', it is more about 'Curriculums or syllabi or courses of study'. So do we. But the same could be said about the document on 'In leather technology, dry salt curing of pig skin using drums', which is input as:

Leather technolgoy 8 Hide and skin 8.4 Skin 8.6 Pig skin 8.1 Beamhouse operation 8.1.4 Curing 8.1.6 Salt curing 8.1.6 Dry salt curing 8.1.5 (using) Drum

The above document definitely gives more importance to the 'method of preservation (of pig skin)' rather than the 'pig skin' itself. But it is the rules of syntax which determined the sequence of terms in this name of subject, not their relative importance. According to Devadason (17, p. 5), "The UNMODULATED but formalised statement of the name of subject *without much attention being paid for the sequence of modifiers* (*not much bothered about Wall-Picture principle*) would be something like this (authors' italics):

Education 8 Curriculums 8.5 (for) In-service trianing 8.5 (of) Semi-skilled workers 8.5 (in) Polytechnics".

This seems to deny those very basic principles upon which the whole system is built. In a similar study on 'Concept specification by PRECIS role operators' Mahapatra and Biswas (36, p. 65) have found that a well-established and institutionalised system like PRECIS is also guilty of such 'manipulations'. The same conclusion could be put forward here that "This sort of input strings can be achieved by the indexer only when his mind is conditioned beforehand to *somehow* bring the required order of concepts to the index entries, and not the *obvious* relationships of concepts within the document, which might lead to poor results in the future". The minor proof of which could be shown from the following online Classaurus entries (which DSIS claims to be capable of generating) (20, p. 34; 12) generated by the above suggested input string:

Curriculums
(for)
– In-service training
(of)
– Semi-skilled workers
(in)
– Polytechnics
[not arranged alphabetically]

It is noticeable that, all three Modifiers of Kind 1, viz., 'In-service training', 'Semi-skilled workers', and 'Polytechnics', are printed at the same level. Because, according to Devadason (17, p. 4), these "do not have any hierarchic relationship. . . . They will be printed at the same indention in the classaurus". But the second entry, i.e.,

Curriculums
(of)
– Semi-skilled workers

is a total distortion of the meaning it was supposed to convey. Instead, an entry like,

Curriculums
(for)
– Semi-skilled workers

would have been more meaningful and desirable in the above circumstances. It is interesting to note Devadason's comments in this respect: "As Austin has said that one should unlearn all about indexing to learn PRECIS, I may say that one should unlearn PRECIS in order to learn DSIS" (17, p. 5). To this we would like to add a further query 'Does one has to unlearn all about the basic classificatory principles to master DSIS?'

3.6.2 Case for Viewpoint

We have seen earlier that, a Modifier can modify a manifestation of any one of the ECs, as well as a combination of two or more manifestations of two or more ECs. The latter, that is "A modifier having the potency of being used to modify manifestations of more than one elementary categories, occurring singly or in combination, is a

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Common Modifier" (8, p. 17). According to DSIS, Common Modifiers can be of Form, Time, Environment and Place. Though Devadason did not explain the nature of the Form Modifier explicitly, it "refers to a common modifier derived from a manifestation of Property denoting a 'Pattern' or 'Style'" (8, p. 18). This could be taken as the physical (outer) or intellectual (inner) form of a document, expressed by terms such as 'Bibliographies', 'Atlases', 'History', 'Biographies', etc.

There are certain terms in the name of subjects which express the viewpoint or opinion of the author. In Langridge's (37, p. 225) opinion, "Fundamental disciplines are by far the most important formal characteristic of documents, but there appear to be six other categories, apart from physical features, with varying degrees of significance". One of these six he refers to as 'Viewpoint'. Ranganathan even showed awareness of its importance by making viewpoint the primary facet in certain Main Classes, the Systems Facet in medicine and psychology being examples. Such viewpoint terms could be regarded as a special kind of inner form, which does not match our normal understanding of the Form Modifier, explained in the previous paragraph. Apart from this, it is also clear that the terms designated as Form Modifier refer to all the preceding concepts in the string, whereas the viewpoint relates more directly to the core concepts in the name of subject. It is, therefore, necessary to introduce this concept at a position in the string closer to terms prefixed by the EC indicators and their subdivisions. For instance, consider the following name of a subject: 'In sociology, Church of England viewpoint towards abortion by pregnant women in the United Kingdom during 1980s'. In this name of subject the 'Church of England viewpoint' directly relates to the issue of 'Abortion by pregnant women', whereas United Kingdom and 1980s merely add the Place and Time dimensions to it. In their comparative study of POPSI and PRECIS, Rajan and Guha (38, p. 379) did not find any similar provision in POPSI, such as we have for the treatment of terms representing 'Viewpoint or perspective' in PRECIS. But in a similar study Bhattacharjee (39, p. 132) showed that concepts denoting 'Viewpoint-as-form' (Role operator 4) in PRECIS could be designated as 'Speciators' in POPSI. For example, a subject such as 'In economics, evaluation of industrial relation from trade union point of view' could give rise to the following subject heading in POPSI:

Economics (BS); Industrial relation (MP): Evaluation − Trade union viewpoint (E)
[where BS = Basic Subject or Discipline; MP = Matter-Property or Property in DSIS; E = Energy or Action; "−" = Indicator for Speciator]

Bhattacharyya (4, p. 14) would probably prefer to call it 'Special Modifier', rather than 'Speciator'. Whatever one calls it, the foregoing discussion shows that there is a genuine need to make provision for introducing such 'viewpoint' terms in indexes created according to DSIS. But this treatment is also unsatisfactory on the ground that, instead of being treated as a Common Modifier, it has been input as a Special Modifier. The same problem could be envisaged in the treatment of 'Target-as-a-form' concepts, which is also being represented as Modifier of Kind 1, especially when the name of subject to be indexed is a Compound Subject[6].

3.7 Applicability to General Indexes

There has been very little use of POPSI (not to mention of DSIS) in practice, except the following (40):

1 Central Machine Tool Institute, India: Machine Tool Abstracts, V. 1; 1972.
2 Indian Council of Social Science Research, New Delhi, India: Mohandas Karamachand Gandhi: A bibliography. 1974.
3 Sangameswaran, S. V. and others: Fish technology: A bibliography 1969–74, 1975.

Sethi and Shyamala (41) have mentioned an experiment conducted in Jawaharlal Nehru University Library, New Delhi, India, since December 1979, in order to test POPSI's validity, which obtained fairly satisfactory results in some of the social science subjects like Economics, Political Science and Sociology. But in order to compete with an indexing system such as PRECIS, DSIS has to show that it could be economically used for the generation of a multidisciplinary index such as *British National Bibliography* subject index. In POPSI (as well as in DSIS) the rules of syntax exercise the main control over citation order while the Discipline controls aspects important for the differences between disciplines (22, p. 107–108). For example, consider a document on the 'hunting of seals by Inuit'. If the Discipline is marine biology, the terms may be cited in the order:

Marine biology 8 Seals 8.1 Hunting 8.1.5 (by) Inuit

If, on the other hand, the Discipline is anthropology, the order may be:

Anthropology 8 Inuit 8.2 Hunting 8.2.5 (of) Seals

Though, this idea of limited control of citation order by the Discipline of the indexed items takes some account of needs of different searchers for different kinds of access, nonetheless, it consumes more input time and output space, hence, in general would be uneconomic to produce.

This necessity for provision by multi-disciplinary approaches to the same or similar topics in a general index compounds the problem which was identified in Section 3.1 relating to polyhierarchical relations in a single discipline. PRECIS solves (or avoids) this problem by treating syntax and semantics as complementary rather than making syntax rigidly dependent on semantics.

4. Conclusions

Thus, on the surface, the computer aided Deep Structure Indexing System may look quite simple (especially to the uninitiated), but inclusion of solutions to the above problems is bound to leave the practitioner with many additional decisions to make using extra process codes. It may also be feared that the Indo-Arabic numerals and the dots used to indicate the ECs and their roles in the Context Headings may prove to be an inadequate repertoire.

However, as it is being advocated that, DSIS is a methodology, not a hard and fast rules-based system, some off the above criticisms may be waived off being

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system-oriented. Whereas, the others still remain valid on the ground that they transcend the system barrier and attack the very basic guidelines upon which it is built. The present study merely unearthes these drawbacks without providing any suitable solutions. It is being hoped that any future modifications would be based on the findings of this study.

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Notes

1 However, there are doubts about the name, DSIS, as Devadason (17, p. 1) himself says that "DSIS is a methodology and provides guidelines and not a 'hard and fast rules-based' system. My calling the computerised POPSI as DSIS is not that correct". For the purpose of this paper we stick to the name DSIS, though, frequent mention of POPSI will be evident, as it is wellnigh impossible to delve into a study of the former without giving due reference to the latter.

2 For the purposes of this paper, following definitions by Craven (22, p. 3–4) have been used as standards: "A *string index* is a form of index with two main characteristics: (1) each indexed item normally has a number of index entries containing at least some of the same terms and (2) computer software generates the description part of each index entry according to regular and explicit syntactical rules. The description part of a string index entry is called an *index string*; the computer software that produces it, an *index string generator*".

3 For a short description of the system, interested readers are requested to consult either reference no. (18) or (23). But the best available description is certainly in the FID/CR report (20).

4 The decisions relating to the use of processing codes are optional and could be varied to suit the individual situations. For example, the decisions relating to the choice of Lead and Context terms could be configured as default options. But synonyms, quasisynonyms and synonyms due to factoring of Composite Terms are to be noted separately to form Cross Reference (CR) Entries to be included in the index before final sorting and printing.

5 The Non-hierarchical Associative Relationship "is a relationship in which terms are not equivalent and are not hierarchically related. The relationship includes among others, entities and their processes and properties, operations and their agents or instruments, actions and the product of the actions, the whole-part relationship other than the hierarchical whole-part, and many others" (28, p. 164–165).

6 A Compound Subject is defined as "A subject with a basic subject and one or more isolate ideas as components" (30, p. 84), e.g., 'In library and information science, subject indexing of newspapers in public libraries'.

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Association for Terminology and Knowledge Transfer

Already in February 1988 the Association which sponsored the 1987 Congress in Trier on "Terminology and Knowledge Engineering" held meetings of two working groups, (1) on the working station of a translator, (2) on the development of a terminological databank. A further meeting of the second group is foreseen for April 22, 1988. At this occasion the organizers expect to release guidelines for the establishment of terminological databanks Anybody interested in this work should turn to Prof.Dr.H.Czap, Gesellschaft für Terminologie und Wissenstransfer eV, Postfach 3825, D-5500 Trier.

Colloque sur l'Histoire de la Terminologie

At the occasion of the 10th anniversary of the Centre de Terminologie de Bruxelles at the Institut Libre Marie Haps at colloquy was organized on 25-26 March 1988 at Brussels with 16 papers, mostly in French. The four sessions and their papers: (1) History of the Science of Terms: H.van HOOF: Histoire du dictionnaire technique. - H.CZAP: Changing aspects of the concept of concept. - J.C.BOULANGER: Evolution du concept de neologie. - G.LURQUIN: A travers l'epaisseur semantique des termes. Traduction speecialiseee et terminologie diachronique. - (2) History of vocabularies: R.HALLEUX: Ruptures et continuites dans le vocabulaire de la chimie et des sciences minerales. -R.GOFFIN: La terminologie des sciences et des techniques nucleaires: un cas de diachronie recente. - A.HERMANS: L'influence des connotations sur l'evolution du vocabulaire de la sociologie. - J.-C.BAUDET: Histoire du vocabulaire de specialite, outil de travail pour l' historien des sciences et des techniques. -(3) Diachronic Terminology and Society: E.de GROLIER: Emergence du vocabulaire scientifique dans l' Antiquite grecque. - Ch.GALINSKI: Influence de l'histoire chinoise sur la communication scientifique et technique en japonais. -J.C.CORBEIL: Quinze ans de politique terminologique au Quebec. - H.JOLY: Apercu retrospectif de la politique francaise en matiere de terminologie. -(4) Prospects: U.HEID: Les attentes des terminologues vis-a-vis des programmes d' elaboration assistee de dictionnaires. - A.MELBY: Vers la multiplication des terminographes? Nouveaux outils d' aide a la terminographie pour micro-ordinateurs. - J.BOITET: Dictionnaires integres multi-cibles et multi-usages (DIMM): une premiere experience. - J.R.HOBBS: Common sense knowledge and lexical semantics.
During the colloquy a number of terminological databanks were demonstrated, such as BELGOTERM, MINCEZEAU, TERMEX, HYPERCARD, and BOOKSHELF. For further information turn to the Secretariat please: Melle M.-O.Mayar, 11, rue d' Arion, B-1040 Bruxelles.

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