A Journey from Cutter to Austin: Critical Analysis of their Contribution in Subject Indexing

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Abstract - *This write-up presents the fundamentals of subject indexing in terms of its development, scope, coverage, role in subject indexing techniques and the important elements to design a well-structured and effective subject indexing process, requirements and the infrastructure. From the time of RDC to PRECIS, the developers has been envisaged the problems to expand the flexibility and versatility of indexing technique. Whenever one indexing process is failed to achieve the maximum efficiency another is developed on the basis of failure. It concludes that all the developments of subject indexing processes during that era are leads to the innovation of Artificial Intelligence technique (AI), i.e. Natural Language Processing (NLP) by implementation of Information and Communication Technology (ICT) in present time.*

Keywords:S ubject indexing, RDC, Systematic indexing, Chain indexing, Relational indexing, KWIC, Subject catalogue, PRECIS.

Preamble: In the context of Library and Information Science (LIS) indexing is a technique of organization, storage and retrieval of bibliographic information has for a long time drawn the attention of experts who have been concerned with finding suitable methods and techniques for processing and organizing the contents of the documents for easy and quick access to information by the users to satisfy their information requirements. Evidences of organizing and archiving written form of information dated back to around 3000BC during Sumerian civilization. Sumerians developed special schemes to store clay tablets because they realized that proper organization and access to the archives was essential for locating and using information.

Indexing is an important tool development by man in a particular stage of social development. Whenever the tool was found lacking in delivering the goods that was desired from it, there was reaction to it from the most sensitive part of the society and attempts were made to improve upon the tool. There are repeated breaks in the continuity of the indexing theories and there developments, during its course of action. A historical review will convince us there is a clear continuity through all search breaks. What is given below; is just an illustrative analysis to notice those breaks and continuities, so that, we may aware about the problems and try to bring about a continuous improvement of the tool in its theories and their application.

Chronological development: Chronological development of subject indexing -

Table 1: Chronological development of subject indexing

YEAR	INDEXING SYSTEM
1876	Charles Ammi Cutter's 'Rules for a Dictionary Catalogue'.
1911	Julius Otto Kaiser's 'Systematic Indexing'.

1933	S. R. Ranganathan's 'Colon Classification' (1st ed.).
1934	S. R. Ranganathan's 'Classified Catalogue Code' (1st ed.).
1945	S. R. Ranganathan's 'Dictionary catalogue code' (1st ed.).
1950	J. E. L. Farradane's 'Relational Indexing'.
1958	H. P. Luhn's 'Key Words In Context'.
1960	E. J. Coates's 'Subject Catalogue'.
1969	Dereck Austin's 'PREservedContextIndexing System' (1st ed.).
1984	Dereck Austin's 'PREserved Context Indexing System' (2nd ed.).

Meaning: The term *'index'* has its origin in Latin and means, 'To point out, to guide, to locate'. According to British standards (BS 3700: 1964), 'A systematic guide to the text of any reading matter or to the contents of other collected documentary material, comprising a series of entries, with headings arranged in alphabetical or other chosen order and with references to show where each item indexed is located".

Objectives: Principal objectives of subject indexing may be summarized as follows –
- To prescribe a standard methodology to indexers for constructing subject heading.
- To be consistent in the choice and rendering of subject entries, using standard vocabulary and according to given rules and procedures.
- To be helpful to users in accessing any desired document(s) from the catalogue through given approach.
- To decide on the optimum number of subject entries and thus economies on the bulk and cost of cataloguing.

Problems: Some problems of subject indexing are –
- The subjects of documents are multi word concept.
- Users approach for information tends to multidimensional.
- Problems arise due to synonyms.
- Problems arise due to lexical variants.
- Problems arise due to semantic drifts.
- Syntactic and semantic relationship between the terms.
- Exhaustivity and specificity level are considered.
- Inter indexer and intra indexer consistency.
- The kind of vocabulary that should be used, syntactical and semantic rules necessary for representing complex subject.
- The problem how to use the index assignment data.

Indexing process: The process of indexing consists of two stages –
- Establishing the concepts expressed in a document: It is also divided into three stages.
- Understanding the overall content of the document, the purpose of author etc.;
- Identification of concept;
- Selection of concept.
- Translating the concepts into the indexing language.

Role of developers: Name of the principle developers of subject indexing are listed above according the year of development. Their roles may be summarized as below –

Cutter's 'Rules for a Dictionary Catalogue': The year 1876 is important for the library professional for the publication of two outstanding books in library science. One is 'Classification and subject index for cataloguing and arranging the books and pamphlets of a

library' by Melvil Dewey and another is 'Rules for a Dictionary Catalogue' by Charles Ammi Cutter.

Cutter wanted to solve the conflict at the cataloguing level. *RDC* brought into sharper relief the conflict between the contents of the documents and the practice of naming them. He never used the term 'indexing' rather 'cataloguing'. He felt that the rule of specific entry was the main distinction between the dictionary catalogue and the alphabetic classed catalogue. The first in choosing between a class and an individual prefers the later. Cutter saw that the name of the subjects of groups or classes which were being utilized as the subject headings for individual documents of the respective classes also were general names covering the subjects of all the documents of these classes, but were not the names of the specific subjects of the different documents under those classes. The root of the conflict remained deep in the classification system also. The classification is not coextensive with the subject in all cases. Representation of the specific subject of a document by a single word or phrase was appeared to be difficult in most cases. So, the full analysis of the subject of the document is made and this situation lays the way for subject indexing from subject cataloguing.

In nutshell Cutter identified two problems in organizing library materials in respect of constructing subject headings. In order to solve the problems of constructing subject headings, Cutter, in his *RDC*, provided rules for specific as well as compound subject heading. Those problems are

Specific subject heading: Cutter did not define the specific subject heading, but the idea was evident in Rule 161 of *RDC*. He advocated, "That we should enter a work under its subject heading, not under the heading of a class which includes that subject". According to this rule, *'Rosales'* should be entered under the *'Rosales'*, but not under the 'Angiospermae'.
However, Cutter gave the following example as a specific subject heading:

Subject of the work	Specific subject heading
Movement of fluids in plant	Botany, Physiological

From the above example, we see that, Cuter gave good idea with bad examples. He breaks his own rule. Here, the example given by Cutter was not in conformity with his own Rule 161. Cutter faced a set of 'stock subject' under one of which every book had to be accommodated. It is impossible to compile a list of 'stock subjects' to represent the subject of each and every document that is produced today.

Compound subject heading: According to Rule 175 of *RDC*, "Enter a compound subject name by its first word inverting the phrases only when some other word is decidedly more significant or is often used alone with the same meaning as the whole name". It means, order of the component terms in compound subject heading should be the one that is decidedly more significant. But, Cutter could not prescribe how one will come forward to decide which one is more significant. A document on 'Social psychology', for example, may be approached both by Sociologists and Psychologists. So, by following this rule, there would be two subject headings for the same document, (a) Psychology, Social and (b) Social Psychology. The decision in respect of 'significant' is left to the judgment of individual indexer, it is subjective one.
Cutter also provided some specific rules and guidelines in respect of the following –
- Person vs. Country: Entry will be under person in case of personal biography. Entry will be under country in case of history, event etc.

- Country vs. Event: Entry under event if it is proper noun. Entry under country if it is common noun.

Subject vs. Country:

- In scientific subjects, entry will be under the subject qualified by place. [*Zoology, India*]
- In areas, such as history, Government, Commerce, entry will be under place qualified by subject. [*India – Mughal Period*]
- For humanities, Literature, Arts etc., adjectival form is to be used. [*Indian Painting*]

- Between overlapping subject: Entry will be according to the importance of the subject.
- Choice between different names:
  - Language- If there are two languages out of which one is English, entry will be under English.
  - Synonyms and antonyms- Entry will be under one word with reference to the others.
- Compound subject heading:
  - A noun preceded by an adjective. [*Political Economy*]
  - A noun preceded by another noun used as an adjective. [*Flower Fertilization*]

o   A noun connected to another noun with a preposition –direct form will be used. [*Fertilization of flowers*]

o   phrases/sentence - direct form will be used. [*Medicine as profession*]

- System of references:
  - Rule 187 of *RDC*: Make references from general subjects to their various subordinate subjects and also to coordinate and illustrative subject.
  - Rule 188 of *RDC*: Make references occasionally from specific to general subject.
  - Though Cutter tried a lot to solve the problems, but he was not successful totally as he could not accommodate all the subjects in a single list and to make a uniform standard rules about order of precedence of compound subjects expressively.

Kaiser's 'Systematic Indexing': Julius Otto Kaiser had the experience of tackling the information problem of the business world. He started from the point where Cutter left. His systematized alphabetical subject heading practice by developing principles behind Cutter's rules, so, as to form consistent grammar logic. He was the first person who applied the idea of Cutter in indexing micro documents in the library of Tariff Commission as its librarian. Kaiser in his *Systematic Indexing* (1911, pointed out that compound subjects might be analyzed by determining the relative significance of the different component terms of compound subject through classificatory approach. He suggested that many compound subjects could be categorized into a combination of concepts indicating Concrete and Process.

According to Kaiser:

- Concrete refers to, things place, abstract terms not signifying any action or process. [i.e. Zoology, Aluminum, India etc.]
- Process refers to
- Mode of treatment of the subject by the author. [i.e. Case study of housekeeping operation]
- An action or process described in the document. [i.e. Indexing of DSpace]
- An adjective related to the concrete as component of the subject. [i.e. Efficiency of computer]

In such cases, the concrete should be given the precedence in the order of citation in indexing. According to Kaiser, the 'concrete' and 'process' for the subject of a document on 'Galvanization of copper' would be 'copper' and 'galvanization' respectively and its subject

heading would be: COPPER- Galvanization. Kaiser also suggested that the country supplies the locality where the action takes place. In the case of no 'concrete' and no 'place', the 'process' remains. But it is preferable to complete the subject heading with 'concrete' in all cases. As a result, arises some unnatural subject heading:-

<u>Documents on</u>   <u>Subject headings</u>
Painting   PAINTS - Application
Strike   LABOUR - Withdrawal

It appears from the above examples that Kaiser could not maintain consistency in the formulation of subject heading. He gave the idea of conceptual categorization but could not apply it properly. He could not analyze deeply the various types of intricacies involved in the naming of subjects, partly because the documented his experience of the world before the first World War which had yet to realize the full scale implication of the knowledge explosion caused by large scale issues of periodical literature. However, his importance lies in his attempt to replace extreme dependence on other's flair for naming of subjects in our records and to show the way for building up our own stock of subject name on the basis of our own power of analysis of subjects supported by a logical thinking.

Besides this, he laid a rule that if 'place' is involved, double entry; once under 'concrete' again under 'place' (*'CONCRETE-Place-Process'* and *'PLACE-Concrete-Process'*) is to be made. For example, index entries for 'Cultivation of corn in Bihar' would be: *CORN-Bihar-Cultivation* and *BIHAR-Corn-Cultivation*. Kaiser recommended that every 'concrete' term should be equipped with cross-references to both hierarchically superiors and inferiors. But, he did not recommend cross-references from 'process' terms.

* The advantages of Systematic indexing are –
    * Categorization of composite terms through classificatory approach ;
    * Definition of those terms, of which 'process' is identified properly, ;
    * A general rule of order of precedence (the 'process' term should follow the 'concrete' term) ;
    * Double entry system for a subject dealing with place ;
    * Elaborate system of references.
* The disadvantages of Systematic indexing are –
    * There is no provision for entry under the 'process' term and as a result it fails to satisfy the users' approach by the 'process' term ;
    * Double entry system is uneconomical ;
    * <u>Kaiser did not provide any concept of 'time'</u> ;
    * Kaiser's prescription of analysis of subject into 'concrete' and 'process' sometimes leads to unnatural headings.

Ranganathan's 'Chain Indexing': Ranganathan starts from the point wher Kaiser left. Kaiser gave the idea of two categories except time, but Ranganathar advocated five categories/facets, namely, Personality [P], Matter [M], Energy [E], Space [S] and Time [T]. His facets analysis of subject provides a kind of representation of subjects by transforming multidimensional relation of subject into a modulated layer of linear presentation. He invented and designed the *Colon Classification* and went on developing it till it was accommodating and flexible enough to deliver the goods with reasonable satisfaction. The chain procedure was born in the bed of the *Colon Classification* scheme. The chain is nothing but a string of terms, just acts like a mirror in terms of the subjects indicating by classes in a classification scheme and the concept is deemed to be a structural manifestation of a subject.

Any systematic method of deriving subject headings for specific subject involves the determination of chain, in which the subject concerned is the last sought link. The term 'structure' in the context refers to the parts, contributing a subject and their mutual interrelationship. So, a 'chain' is, we may say, a modulated sequence of subclass or isolate ideas.

According to Ranganathan, a 'chain procedure' is, "Producing for deriving Class Index Entry (i.e. Subject Index Entry) which refers from the name of a class to its class numbers in a more or less mechanical way. A note is also Class Index Entries in a Classified Catalogue, and Specific Subject Entries, Subject Analytical, and See also Subject Entries in a Dictionary Catalogue".

As the 'chain' expressed the modulated sequence more effectively in a notational classification of subjects, this method takes the class number of the document concerned as the base of deriving subject headings, not only 'specific subject entry', but also for 'subject reference entries'. Thus, this method may be used to provide indexes not only to *Classified Catalogue Code* and *Colon Classification* scheme, but also to *Dictionary Catalogue* and to other classification (i.e. *Dewey Decimal Classification*) scheme.

0.1.1. Links: The concept of 'chain' becomes operative only after the concept of a set 'links' about the structure of the subject is conceded. A 'chain' should comprise a 'link' of every order that lies between the first and 'link' of the 'chain'.Each links consists of two parts, class number and its verbal translation in standard term by following given classification scheme. The different types of 'links' in 'chain indexing' are as follows:
- Sought link (SL) - It denotes those concepts (at any given stage of the chain) that users is likely to use as access points.
- Unsought link (USL) - It denotes those concepts (at any given stage of the chain) that users is not likely to use as access points.
- False links (FL) – These are really do not represent any valid concept, generally these are connecting symbols, indicator digits etc.
- Missing links (ML) – These represents those components that are not available in the given classification scheme, these are inserted by the indexers by means of verbal extension at the chain-with-gap corresponding to the missing isolate in the 'chain' when required.

Specific Subject Heading: Derive specific subject heading for the specific subject entry from the last sought link and moving upwards by taking the necessary and sufficient sought links in a revers rendering process. If the subject includes a isolates (space, time, form) break the chain into different part(s) at the point(s) denoting space, time, form in the class number. Specific subject heading is to be derived from last SL of first part in revers rendering process and then by second part, third part etc. in the similar process.
So, we may say,

$$SSH = SH_1 + SH_2 + SH_3 + SH_4$$

Subject of a document	Class number
Research on child psychology in India	155.4072054(DDC 22nded.)

Determination of links:

100	Philosophy, Parapsychology and Occultism [USL]
150	Psychology [SL]

155	Differential and developmental psychology [USL]
155.	[FL]
155.4	Child psychology [SL]
155.40	[FL]
155.407	Education, research, related topics [USL]
155.4072	Research [SL]
155.40720	[FL]
155.407205	Asia [USL]
155.4072054	India [SL]

Specific Subject Heading: Research, Child psychology, India

Subject Reference Heading: Derive subject reference heading for the subject reference from each of the upper sought links. The process continues until all the terms of upper sought links are exhausted and indexed.
So, we may say,

$$SRH = SH_4 + SH_3 + SH_2 + SH_1$$

Here,   Research, Child psychology
        Child psychology
        Psychology

Subject Reference Entries: Prepare subject reference entries or 'see also' references from each subject reference heading to its specific subject heading. When a subject heading starts from last sought link denoting space or time or form, prepare 'see' references instead of '*see also*'.

 Here,   Research, Child psychology   155.4072
                           See also
                           Research, Child psychology, India
                           Child psychology   155.4
                           See also
                           Research, Child psychology, India
                           Psychology   150
                           See also
                           Research, Child psychology, India
                           India, Research, Child psychology
                           See
                           Research, Child psychology, India

Cross References (if any): Prepare cross references or 'see' references for each alternative and synonymous term/heading used in the specific subject heading as well as subject reference headings. Here,   India, Research, Child psychology

Advantages: Some advantages lies in the 'chain indexing'. These are –
• To ensure the collocation of aspects of a subject which have been scattered in the classification scheme, as last link of the class number is always the first link in the of subject index entries.
• To offer general as well as specific information to users by deriving subject headings from the chain of successive subdivisions that leads from the general to specific level.
• It is economic also by more or less a mechanical system.

Drawbacks: It has some disadvantages also. These are –
- Very much depends on classification scheme – If it is based on a structurally defective classification scheme, the subject headings will naturally become defective.
- Disappearance of chain – 'Chain' disappears in each stage of deriving subject reference entries and thus it results in the loss of full context of the content of the document.
- Lack of specificity – 'Chain indexing' provides only one specific entry and other are subject references.
- Unsuitability for machine – The formation of 'chain' is very much a human intellectual processes which is logically absurd for the computer to manipulate.
- Running from pillar to post – In most cases access to specific subject heading was possibly at the cost of running from pillar to post since only one entry is specific subject entry and others are cross references.

J. E. L. Farradane's 'Relational Indexing': Farradane wishes to find out relation concepts by following the learning process through which we develop our power of discrimination in time and space. He developed 'Relational Indexing'. The relationship between each pair of terms of a given subject and to represent those relations by relational operators suggested by him and thus creating 'Analets'.He has formulated the basic idea of relational analysis by studying the development of learning process with particular reference to child psychology. He advocated that there is no need of 'categorization'. Though, he himself breaks his own rules by providing the idea of nine different kinds of relations with symbolic indicators. These are: (i) Concurrence (/0), (ii) Self-activity (/*), (iii) Association (/;), (iv) Equivalence (/=), (v) Dimensional (/+), (vi) Appurtenance (/(), (vii) Distinctness (/)), (viii) Reaction (/–) and (ix) Causation (/:).
Farradane's Relational Indexing offers no rule for filing order for the component terms in an index entry. If the reverse order of the components is required then the necessary operators are also required to be written in the reverse order. i.e. 'Depression / : Cyclone' can also be written as 'Cyclone : / Depression'.

H. P. Luhn's'Key Words In Context': During the 1950s, scope for use of machines to do some library jobs at an unimaginably terrific speed further title the situation in favour of some indexing method which would not demand the intellectual rigour of doing some intensive exercise in classification before getting the name of subjects in natural language terms. In 1953, CIA began to prepare permuted title word index with the help of machine. In 1958, the method was adopted for organizing some CAS with the help of computer by Hanes Peter Luhn in IBM as *'Key Words In Context'* (KWIC).

Under this system each significant word in a title becomes an entry point as in *catch word indexing*, with this the entries from the manipulation of the title are filled in alphabetical sequence of filing words as well as insignificant words are ignored and do not give rise to index entries.
- Weakness: The major drawback of KWIC lies in the fact that it indexes under only one single key word under which there may be a very large number of entries which have to be glanced through by anuser to see if it contains anything of interest to him/her.

E. J. Coates's 'Subject Catalogue':E. J. Coates was the founder editor (1963-1976) of British Technology Index. Now it is known as, Current Technology Index. Coates, however, accepts the basic logic behind Kaiser's categorization of the concepts into 'concrete', 'process' and 'place'. Coates names them a little differently as 'thing' and 'action' and then explains how other idea components can be analyzed and fitted into this primary structure.

He gave two ideas, namely, (i) terms significance and (ii) term relationship. The idea of first one is derived from the principles of Cutter, Kaiser and Ranganathan. The second idea, on the other hand, derived from the principles of Farradane.It was advantageous for Coates to apply his idea on Current Technology Index. 'Galvanization of copper, for example, COPPER [Thing] — Galvanization [Action]. Among 'thing' and 'action', 'thing' is more significant than 'action. Apart from that, Coates also added the idea of 'material'. A 'material' is a state images produced by names of 'things' and names of 'material'. A 'thing' is made up of certain 'material' and the 'material' follows the 'thing'. 'Material' is made of some static seeming properties— i.e. colour, hardness, smoothness, etc. Therefore, the significant order is Thing—Material—Action just like Personality—Matter—Energy of Ranganathan.Partis a component of a thing. Hence, it depends on the thing towhich they belong and, thus, giving us the order of significance: Thing–Part–Material–Action.

Apart from significance order, compound subjects may include two or more equally concrete things, or a complex subject may incorporate two or more phrases, which sometimes bring problems subject may incorporate two or more phrases, which sometimes bring problems of the compound term is considered.

Coates has provided a very valuable corollary of his ideas on significance order. Coates broke each phrase into terms with necessary preposition in between them which he called Amplified phrase order. Amplified phrase order is the order of component terms achieved by using the necessary prepositions in between them.

Austin's 'PREserved Context Indexing System': Since 1952, British National Bibliography (BNB), for about 20 years, was following 'Chain indexing' for deriving subject index entries. But, at the later part of 1960s, when Dr. Dereck Austin developed '*PREserved Context Indexing System*' (PRECIS) and from then, BNB used PRECIS instead of 'Chain indexing'. Two most important factors played significant role in looking for an alternative method which ultimately resulted in the development of PRECIS:
a.   Idea of replacing chain indexing technique of BNB ; and
b.   The decision of British Library to generate computer produced BNB with all the indexes.

Up to that time the BNB had three parts:
a.   Classified main part in which entries were organized according to DDC number ;
b.   An alphabetical index of authors, titles etc. (i.e. Name index) ; and
c.   An alphabetical subject index derived according to the chain procedure.
It was possible to produce (a) and (b) directly from the MARC tape. But there are no satisfactory source of subject index data was available in MARC. The chain indexing procedure so long being considered as the most versatile and logical method for deriving subject heading and used worldwide had to face certain disadvantages particularly in the context of mechanization. These are as follow –
a.   Unsuitability for machine – The formation of 'chain' is very much a human intellectual processes which is logically absurd for the computer to manipulate;
b.   Very much depends on classification scheme ;
c.   In most cases access to specific subject heading was possibly at the cost of running from pillar to post since only one entry is specific subject entry and others are cross references.
That is why, a research for a suitable alternative for generating subject indexes were undertaken by British Library with the following objectives, which ultimately resulted in the development of PRECIS:

a. The computers instead of indexers should produce all index entries. The indexer's responsibility would be only to prepare the input strings and to give necessary instructions to the computer to generate indexes according to definite formats ;
b. Each of the sought terms should index entries and each entry should express complete thought content of the document unlike the chain indexing where only one entry is fully co-extensive with the subject and others are cross-references describing only one aspect of the complete content of the document;
c. Each of the entries should be expressive ;
d. The system should be based on a single set of logical rules to make it consistent ;
e. The system must have sufficient references for semantically related terms.

Syntax and semantics: PRECIS consists of two interrelated sets of working procedures –
Syntactical: Syntactical relationships in PRECIS are handled by means of a set of logical rules, a schema of role operator and codes.

Semantic: Semantic relationship between indexing terms and their synonyms are regulated by machine held thesaurus; that serves as the sources of *see* and *see also* references in the index.
**Principles:** The PRECIS based on two principles. These are –

Context dependency: As for example,
Kalyani – Unideysity of Kalyani – DLIS – Teaching.
In the above string of terms, each of the terms sets the next term into its most obvious wider context (general to specific).

One to one relationship: When terms are organized in context dependent order, they from a one to one related sequence. This simply means that each of the terms in the string is directly related to its next term.

Entry structure: The context depend terms in the above string also express the same meaning if set down in the reverse order. So, either the first term or the last term, in such a sequence, can be considered as the entry point of approach term. But, the problem arises when one of the middle terms is considered as the entry point. KWIC does not solve the problem and fails to achieve the principle of context dependency.
In order to achieve the principle of context dependency, *two line three part* entry structure is followed in PRECIS. The parts of the structure are named as follows:
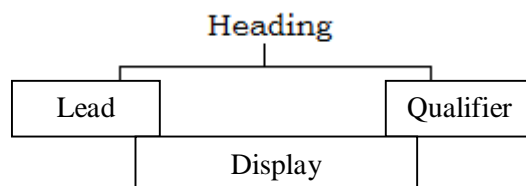
Lead: It is the approach or filing term and is offered as the user's access point in the index. It is printed in bold type face.
Qualifier: This term(s) that sets the lead into its wider context (general to specific).
Lead + Qualifier = Heading.
Display: Those terms which rely upon the heading for their context. Somehow these positions become empty when lead is occupied by the last term of the input string.
Process of index entries: The regulation of index entries of PRECIS are –
Input string - The input string will be prepared according to role operator.

Role operators- It serves as computer instructions for determining the format, typography and punctuation associated with each index entry. There are two kinds of role operators –

Primary operators: It consists of numbers in the range 0 to 6 having built in filing value. Though, certain conditions must be satisfied while writing the input string. These are –
i.   Every string must begin with a concept coded with an operator in the range (0) to (2) ;
ii. Every string must begin contain a concept which is prefixed by the operator (1) and/or (2)
Secondary operators: It can be introduced into a string at any point to raise its level of exhaustivity, but, these operators can't be used to start a string, these are always preceded by the primary operators to which these relates.

Codes: The provision of codes for bringing expressiveness in the resulting index entries. There are three types of codes – (a) Primary (b) Secondary and (c) Typographic.

Generation of index entries: There are three formats are considered for generation index entries. These are –

Standard format: Index entries in the standard format are generated with the primary operators (0), (1), and (2) through the process, known as *shunting*, by the computer.

Inverted format: Index entries in this format are generated whenever primary operators are (4), (5) and (6). In this format whole input sting is read from top to bottom and it is written in the display.

Predicate transformation: When an entry is generated under a concept coded by (3) which immediately follows a concept coded either by (2) or (s) or (t), the predicate transformation takes place.

Steps in PRECIS: Major steps involved in indexing according to PRECIS include the following –
1. Analysing the thought content of the document concerned and identifying the component terms denoting key concepts.
2. Organizing the component terms into a subject statement based on the principle of context dependency.
3. Determining the role or status of each term in terms of role operators.
4. Assigning the role operators, which signify the syntactical role of each term.
5. Deciding which terms should be the access points and which terms would be in other positions in the index entries, and assigning further codes to achieve these results.
6. Adding further prepositions, auxiliaries or phrases, this would result in clarity and expressiveness in the resulting index entries.
7. Generation of index entries by the computer.
8. Generation of supporting reference entries (i.e. '*see*' and '*see also*') from semantically related terms taken from a machine-held thesaurus.

Example: A thesis on economic aspect of the design on Bengali scripts based digital archive of cultural heritage site of West Bengal with reference to the 18ᵗʰ century tomb of Murshidabad district.
(0)   West Bengal (LO= Lead Only)
(1)   heritage sites $21 cultural
(p)   archive $21 digital $22 Bengali scripts based $w for
(2)   design $wof
(4)   economic aspects

(5)   study examples
(q)   tombs $d 1700-1799
(5)   study regions
(q)   Murshidabad $n district
(6)   thesis

West Bengal
Design of Bengali scripts based digital archive for cultural heritage site - *Economic aspects – Study examples : Tombs, 1700-1799 – Study regions : Murshidabad (District) – Thesis*

Heritage site
Design of Bengali scripts based digital archive for cultural heritage site - *Economic aspects – Study examples : Tombs, 1700-1799 – Study regions : Murshidabad (District) –Thesis*

Cultural heritage site
Design of Bengali scripts based digital archive for – *Economic aspects – Study examples : Tombs, 1700-1799 – Study regions : Murshidabad(District) –Thesis*

Archive. Cultural heritage site
Design of Bengali scripts based digital archive for – *Economic aspects – Study examples : Tombs, 1700-1799 – Study regions : Murshidabad(District) –Thesis*

Digital archive. Cultural heritage site
Design of Bengali scripts based digital archive for – *Economic aspects – Study examples : Tombs, 1700-1799 – Study regions : Murshidabad (District) - Thesis*

Bengali scripts based digital archive. Cultural heritage site
Design of – *Economic aspects – Study examples : Tombs, 1700-1799 – Study regions :Murshidabad (District) - Thesis*

Design. Bengali scripts based digital archive. Cultural heritage site
– Economic aspects – Study examples : Tombs, 1700-1799 – Study regions :Murshidabad(District) –Thesis

Economic aspects
Design of Bengali scripts based digital archive for cultural heritage site - *Economic aspects – Study examples : Tombs, 1700-1799 – Study regions :Murshidabad(District) –Thesis*

Tombs.*Study examples*
Design of Bengali scripts based digital archive for cultural heritage site - *Economic aspects – Study examples : Tombs, 1700-1799 – Study regions :Murshidabad(District) –Thesis*

Murshidabad (District).*Study regions*
Design of Bengali scripts based digital archive for cultural heritage site - *Economic aspects – Study examples : Tombs, 1700-1799 – Studyregions :Murshidabad(District) –Thesises*

Thesis
Design of Bengali scripts based digital archive for cultural heritage site -
Economic aspects – Study examples : Tombs, 1700-1799 – Study regions :Murshidabad(District)

7. Conclusion:

The above discussion provides an illustrative view of mainly theoretical and partly practical aspect of subject indexing. It is impossible to understand the subject indexing properly, without being aware of the different principles and processes associated with it. That is why, different aspects of subject indexing principles and processes are discussed at the write up. It is followed by the discussion on the significant contributions made in the areas of pre–coordinate subject indexing systems at different points of time since the days of Cutter to Austin. Though, the traditional subject indexing systems and techniques have taken a new turn with the implementation of Information and Communication Technology (ICT) since the World War II.

References:

1. Austin, D. (1984).PRECIS: A Manual of Concept Analysis and Subject Indexing.(2nd ed.). London: British Library Bibliographic Services Division.

2. Chatterjee, A. (1998). Indexing language: Features and types.In S. B. Ghosh, & J. N. Satpathi (Eds.), Subject indexing system (pp. 27-40).Kolkata: IASLIC.

3. Cutter, C. A. (1904). Rules for a Dictionary Catalog. In W. P. Cutter, ed. (4th ed.). Washington: Government Printing Office, 1904. (Reprinted from The Library Association, London.1962.)

4. Sarkhel, J. K. (1998). Subject indexing by PRECIS. In S. B. Ghosh, & J. N. Satpathi (Eds.), Subjectindexing system (pp. 140-187).Kolkata: IASLIC.

5. Sarkhel, J. K. (1999). Subject Indexing, Vocabulary Control and Recent Developments in Cataloguing.Library Cataloguing Theory, (BLIS 04). New Delhi: Indira Gandhi National Open University.

6. Sarkhel, J. K. (2001). Information Analysis in Theory and Practice. Kolkata: Classique Books.

7. Sinha, M. P. (1998). Subject indexing by chain procedure. In S. B. Ghosh, & J. N. Satpathi (Eds.), Subject indexing system (pp. 85-139).Kolkata: IASLIC.