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Ranganathan's elucidation of *subject* in the light of 'Infinity (∞)'

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This paper reviews Ranganathan's description of *subject* from mathematical angle. Ranganathan was highly influenced by Nineteenth Century mathematician George Cantor and he used the concept of infinity in developing an axiomatic interpretation of subject. Majority of library scientists interpreted the concept of subject merely as a term or descriptor or heading to include the same in cataloguing and subject indexing. Some library scientists interpreted subject on the basis of document, i.e. from the angle of the concept of *aboutness* or *epistemological potential* of the document etc. Some people explained subject from the viewpoint of social, cultural or socio-cultural process. Attempts were made to describe subject from epistemological viewpoint. But S R Ranganathan was the first to develop an axiomatic concept of subject on its own. He built up an independent idea of subject that is ubiquitously pervasive with human cognition process. To develop the basic foundation of subject, he used the mathematical concepts of *infinity* and *infinitesimal* and construed the set of subjects or universe of subjects as continuous infinite universe. The subject may also exist in extremely micro-form, which was termed as spot subject and analogized with point, which is dimensionless having only an existence. The influence of Twentieth Century physicist George Gamow on Ranganathan's thought has also been discussed.

Keywords: Subject; Continuous Infinite Universe; S R Ranganathan; Ranganathan's school; Infinity; Infinitesimal; George Cantor; George Gamow; Set theory

Introduction

The concept of *subject* is an elemental kernel of library science, which is a classical branch of knowledge related with libraries. Later, information science was coupled with library science in various changing contexts. But the importance of the study of subject as fundamental component still bears significance. Actually, library and information science may be reckoned as the *subject of the subjects*. A subject is part(s) of human knowledge, which is an ever-changing entity. The changes are governed by many factors, viz. 1) Time 2) Interaction with other subjects and 3) Applicability in real life. The dynamic locus of a subject is best traced out by its sources of information, both primary and secondary, for instance research papers published in journals, patents, thesis, books, reports etc. A subject has following fundamental components:

- Content: actual matter dealt therein
- Context: relevant framework in which the subject is discussed
- Concept: the main theme playing behind the subject

All these three components affected by above-mentioned three factors, i.e. time, interaction, and applicability. There are so many connotations of the word *subject*. The related words generally used for the word *subject* in different literature are, among many others, *aboutness*, *content*, *theme* and *topic*. It is difficult in many situations to clearly define the subject of a document. The pioneers of library and information science interpreted the concept of *subject* in many ways. Major contributors to the theory of subject analysis are Cutter[1], Drake[2], Wilson[3], Hutchins[4,5,6], Maron[7], Miksa[8], Soergel[9], Molina[10] and Hjørland[11,12,13].

Subject: different definitions

According to Cutter[1], the stability of subjects depends on social process in which their meaning is alleviated in a standard vocabulary. His notion interpreted subjects as some intellections, which receive a name that itself represents a discrete harmony in usage. In Cutter's view, subjects are by their very nature indicate locations in a classificatory structure of publicly accumulated knowledge. It is clear that Cutter emphasized subject descriptor or subject heading rather than an axiomatic concept of subject. Drake[2] also emphasized subject descriptors and accepted the concept of subject as organized knowledge corpus evolved in course

of social changes. The concept of subject in library and information science was given by Wilson[3]. He examined by thought experiment the suitability of different methods of examining the subject of a document. The methods described are:

1. To identify the author's purpose for writing the document
2. To assign weightage to the relative dominance and subordination of different elements in the picture, which the reading imposes on the reader
3. To group or count the documents used of concepts and references
4. To deduce a set of rules for selecting the elements which are necessary as opposed to unnecessary for the work as a whole

Wilson concluded that each of these methods is insufficient to determine the subject of a document and remarked: "The notion of the subject of a writing is indeterminate". He also said that authors of documents often use terms in ambiguous ways. Even if the librarian could personally develop a very precise understanding of a concept, he would be unable to use it in his classification, because none of the documents use the term in the same precise way. Based on this argumentation Wilson made the conclusion: "If people write on what are for them ill-defined phenomena, a correct description of their subjects must reflect the ill-definedness".

A number of LIS researchers apparently solved the difficulties hidden in the concept of subject by preferring to use the concept "aboutness" as an alternative. A justification for this decision was given by Hutchins[5]:

> *From this account of indexing one thing should now be clear, namely, that the notion of the "subject" of a document is peculiarly vague. We may mean the "extensional aboutness" or the "Intentional aboutness", as given by the author in his title or as given by the abstractor or by the indexer; we may mean the NL [natural language; BH] phrase expressing the Topic or we may mean the DL [documentary language; BH] expression denoting the document content. There are clearly so many variables involved that whenever we talk of the "subject" of a document we ought always to say what kind of subject we are intending.*
>
> *As we have seen, judgments of subject content (by authors, readers and indexers) are influenced by so many factors that any particular statement of a document's content should never be regarded as anything other than just one of many possible such statements. In other contexts and from other perspectives the same document may have other, quite different 'subjects'.*

Maron[7] discussed the concept of *aboutness* and interpreted the same in terms of search behavior. He showed that *aboutness* is not the central concept in a theory of document retrieval. He mentioned, "A document retrieval system ought to provide a ranked output (in response to a search query) not according to the degree that they are *about* the topic sought by the inquiring patron, but rather according to the probability that they will satisfy that person's information need". He related the concept of *aboutness* with the probability of user's satisfaction. Miksa[8] sketched an integrated outline of subject headings used in dictionary catalogue since Cutter's time to his contemporary period. It is clear from Miksa's overview on historical account of evolutionary stages of subject-heading concept that in LIS, researchers mostly concentrated on subject terms or descriptors for the purpose of subject indexing and cataloguing. Therefore the phrases like *subject-descriptor* or *subject-term* or *index-term* etc. are frequent casual misnomers in LIS for the word *subject*. An axiomatic development of intrinsic concept of subject has been so long observed within the purview of epistemology and cognitive psychology. Cutter discussed with subject descriptors or subject index terms only, but no axiomatic concept of subject was presented. Soergel[9] emphasized on information organization through appropriate choice of subject descriptor terms. His emphasis was also chiefly on subject headings. Molina[10] discussed with content analysis, which is restricted within the limits of written textual documents. He concerned *text*, as an indivisible part of semiotic research, and *content*, as the informative power of text. In his view, the content analysis should be executed in an inter-subjective manner with regard to the context, the analyst's knowledge base and the documentary objectives. He put forward the idea of *subject* on the basis of context-based content analysis.

The view proposed by Hjørland[11,12] emphasizes that subject analysis is always done from a given perspective and purpose. The goal of subject analysis is to support some activities of users, which are defined by the explicit or implicit purpose of the information service that undertake the subject analysis. Thus two different types of library and information services, say a physical science database and a public library need different kinds of documents and different kinds of descriptions and subject analysis.

The concept of *aboutness* is thus introduced in order to solve the problem relating to the concept of *subject*. The term *aboutness* was coined by Fairthorne[14] in 1969. This term was coined in the context of philosophy, but it became popular in the field of library and information science since early seventies. Hutchin's interpretation of subject much popularized this term as it removed some epistemological problems from interpretative arguments of subject. Hjørland[11, 14] found that any practice of subject determination as well as any theory of subject analysis is necessarily based of epistemological views. Those views are, however, seldom explicit, and often unknown because of lack of epistemological knowledge in Library and Information Science. Each approach to subject analysis and information retrieval is more or less based on specific epistemological assumptions. Facet analysis, IR-approaches, user-oriented approaches, bibliometric approaches etc. are basically related to different epistemological views which implies different conceptions of what subjects are. Based on this analysis, Hjørland[11] developed a new understanding of subjects as *informative potentials* (first formulated as *epistemological potentials*), i.e. the subjects of a document are its informative potentials. The basic idea is simple to explain. Rather than seeking the subject of a document, for example, in some inherent objectives and facts about that document, the indexer should ask: *What is this document useful for?* In other words, the subject assignment is seen as a human act, which aims at supporting some activities of the users. The subject determination that is most successful in accomplishing this goal is the most correct one. Consequently subject determinations are situational and context-dependent. The subject of a document is also theory-dependent. Just as one could not describe the potentials of uranium as an energy source before the development of physical theories of radioactivity, the potentials of documents are changing when theories change. This is best understood by considering the citation patterns and reception history of documents. Although uranium could not be described as an energy source before the development of theories on radioactivity, uranium nonetheless contained the potentials all the time. The same is the case with documents. Their potentials may be unrecognized for a long time, but nevertheless they exist.

Metcalfe[15] provided an overview of the history of the concept in libraries for almost hundred years. Metcalfe concluded, the subject of a document often seems so obvious, that it is hard to imagine alternatives or to understand that deep theoretical problems should be or could be involved. However, the notable feature is that different persons may have good reasons to ascribe different subjects to the same document that it is illusory to speak of the one true subject of a document disregarding the situation and the purpose of the describing activity. It is thus better to say anything whatsoever may be ascribed a subject by somebody for some purpose. If considered this way then the subject is something that is ascribed to documents or to other objects, but not something with an independent existence beyond this ascribing activity. But then what is it that is being ascribed? And that obvious question still remains, *What is a subject?*

Frohmann[16] said:

> *The stability of the public realm in turn relies upon natural and objective mental structures which, with proper education, govern a natural progression from particular to general concepts. Since for Cutter, mind, society, and SKO [Systems of Knowledge Organization] stand one behind the other, each supporting each, all manifesting the same structure, his discursive construction of subjects invites connections with discourses of mind, education, and society. The DDC [Dewey Decimal Classification], by contrast, severs those connections. Dewey emphasized more than once that his system maps no structure beyond its own; there is neither a "transcendental deduction" of its categories nor any reference to Cutter's objective structure of social consensus. It is content-free. Dewey disdained any philosophical excogitation of the meaning of his class symbols, leaving the job of finding*

> *verbal equivalents to others. His innovation and the essence of the system lay in the notation. The DDC is a poorly semiotic system of expanding nests of ten digits, lacking any reference beyond itself. In it, a subject is wholly constituted in terms of its position in the system. The essential characteristic of a subject is a class symbol which refers only to other symbols. Its verbal equivalent is accidental, a merely pragmatic characteristic...*
>
> *The conflict of interpretations over "subjects" became explicit in the battles between "bibliography" (an approach to subjects having much in common with Cutter's) and Dewey's "close classification". William Fletcher spoke for the scholarly bibliographer.... Fletcher's "subjects", like Cutter's, referred to the categories of a fantasized, stable social order, whereas Dewey's subjects were elements of a semiological system of standardized, techno-bureaucratic administrative software for the library in its corporate, rather than high culture, incarnation.*

Frohmann's interpretation implies DDC scheme more as an empirical approach to subject classification rather having any concrete theoretical background.

Stam[17] is critical about subjects as basis for groupings of knowledge. However, he was concerned with that aspect of subject matter, which is usually called topic or topicality. He stated that subject matter is the weakest criterion for generic groupings because it fails to take into account how the subject is treated. The subject matter of documents is usually described by terms related to method and genre involved in the topic and those terms are regarded as the subject description of a document. The ambiguities in the concept of subject along with different logical aspects were discussed by Hjørland & Nicolaisen[18] from the viewpoint of Bradford's phenomenon of scattering.

Definition of subject: the first breakthrough

Different scientists describe the concept of subjects from different views. No single description leaves any complete picture of the concept of subject, but an overall study of all theoretical formalism draws a comprehensive layout of the criteria. The notable feature is that, in all theories so long discussed the concept of *subject* is based on the epistemological formalism. Here the term *subject* has been conceived as a built-in conceptual entity of a document. An attempt to develop document-independent conception of subject is highly relevant particularly at this time of frequent proliferation of concepts that results in regular burgeoning of inter- and multi-disciplinary subjects. On listening the word *subject* normally people throw questions like that, what is the subject of a document, or an article, or a research paper, or a communication, or a topic discussed, or a movie, or a seminar, or a lecture etc. etc. That is to say the concept of subject is imbibed in the concept of document or research paper, or lecture, whatever it may be. The subjects may be considered in these regards as the conceptual entity associated with any document or human communication in any form whatsoever. But an essential question may then arise, what is the axiomatic concept of subject? How to define the concept of subject without any backing of the concepts of document and human communication in any form? Basically the interaction between human cognition and nature is the father of knowledge, wherefrom subjects were created. The origin, growth and structural aspects of knowledge are elaborately discussed in epistemology. The concepts of subjects are thus long prior to the inception of documents. Therefore the concept of subject should be independently developed irrespective of the concept of document. This attempt was first made by Ranganathan[19]. He coined the phrase *universe of subjects* and defined various modes of formation of subjects. Later on, Gopinath[20] and Seetharama modified Ranganathan's concepts. Recently Sen[21] also added some new modes of subject formation. The word *subject*, in the context of library and information science mostly indicates *subject descriptor* or *subject heading*. Because the prime objectives of library and information professionals are cataloguing and subject indexing. The major function of library and information theorists thus focuses on development of various subject access tools like classification schedules or list of subject headings. The main objectives of subject access tools are to describe the content of documents and all other forms of human communication in terms of some indexing language, which is by and large an artificial language. The development of an axiomatic concept of subject therefore comes under the purview of epistemology in the study of growth and structural aspects of

knowledge. The document-independent conception of subject may be originated from the study of growth and evolution of knowledge.

Ranganathan's treatment of *subject* in *Prolegomena to Library Classification*

A system providing an optimum logical interpretation of the concept of subject and having an explicit theoretical foundation is Ranganathan's Colon Classification. As far as known Ranganathan is the only researcher who have earlier given an explicit definition of the concept of subject[19]:

Subject - an organized or systematized body of ideas, whose extension and intension are likely to fall coherently within the field of interest and comfortably within the intellectual competence and the field of inevitable specialization of a normal person.

Another definition was given by Gopinath[20]:

A subject is an organized and systematized body of ideas. It may consist of one idea or a combination of several....

Ranganathan's definition of *subject* is based on Colon Classification system. The Colon classification is an analytico-synthetic scheme, which is based on the combination of single elements from facets to subject designation. The term *Facet* implies another entity, which was also defined by Ranganathan in this connection. He defined *Facet* as the component of subject. The exact definition was, "Facet is a generic term used to denote any component- be it a basic subject or an isolate- of a compound subject, and also its respective ranked forms, terms and numbers"[19]. Apart from *basic facet* and *isolate facet*, Ranganathan exemplified so many other facets like, geographical facet, language facet, wave length facet, commodity facet, substance facet, organ facet, cultivar facet and so on. This aspect of Ranganathan's theory was discussed by Metcalfe[15] also.

Ranganathan introduced the phrase *Continuous Infinite Universe* to clear the concept of subject. Some definitions given by Ranganathan in *Prolegomena to library classification* are presented below:

Infinite Universe: A universe containing an infinite number of entities. The positive integers form an infinite universe. However great an integer may be another integer can be got by adding 'one 'to it. Therefore the concept of greatest integers is ruled out. It is this attribute of the universe of positive integers that is denoted by the statements," The universe of positive integers is an infinite universe".

Complete Division: A complete division of an Infinite Universe is not possible. In other words, to whatever stage the process of division is carried, there will always be some multiple groups in addition to unitary groups, if any, formed. Consequently, all the entities will not stand separated whatever be the stage to which the division is carried. A little thinking will show the truth of this when applied to the universe of positive integers or to the universe of lattice points.

Continuous Infinite Universe: An infinite universe, with the entities so packed that it is impossible to extract any single entity form of its neighbouring ones – to put it better, it is impossible to reach at any single entity.

Example:

Universe of points in a straight line: Let us consider a straight line as a universe of point. Let us divide it into intervals. Each interval will have many points. In other words it is multiple groups. Let us denote one of these intervals or multiple groups by A1. Let us next divide the interval A1 into sub intervals. Each interval is a sub group of points. In other words, it is also multiple groups. Let us denote one of these sub interval or multiple groups by A2. Let us continue this process of division into sub interval. Whatever be the stage of division reached, each resulting interval will still be a multiple group. In other words at no stage of division, a unitary group – that is a single point –will be reached. It is this attribute of the universe of the universe of point in a straight line that is denoted by the statement, "The universe of points a straight line is a Continuous Infinite Universe ". As an aside it may be stated that this attribute of a straight line come points that has led to the statement, "A point has position but no magnitude".

Universe of straight lines in a plane: A similar statement is that "A straight line has line length and position in a plane but no width ". A little thought will show that the universe of straight lines in a plane is a continuous infinity universe.

Universe of points in a plane: Again, if we consider all the points in a plane – and not merely the lattice

points- we may state that the universe of all the points in a plane is a continuous infinite universe.

Universe of subjects and unitary class: This idea can be extended to space of any number of dimensions. The universe of subject corresponds to such a space. This should be brought to the level of reflex action by revolving it in the mind sufficiently. The repetition of the statement, "Universe of subjects is a continuous Infinite universe ", is not sufficient. Every effort should be made as quickly as possible to comprehend it as a fact in the idea plane.

Parameter and Dimension:

Parameter: Parameter is mathematical term, the term 'Parameter 'means an arbitrary constant, each particular value of which characterizes some particular member of a system of functions, curves, or surfaces. In the classification of a universe of isolate ideas, each of the successive characteristics used in arriving at an isolate idea are therefore, sometime referred to as the 'parameter 'of its classification. Similarly, in an enumerative classification each of the successive characteristics used in arriving at a subject is also a 'Parameter' in this sense.

Dimension: Dimension is the mathematical term, the term Dimension 'means the degree of manifoldness of an aggregate as fixed by the number of parameters necessary and sufficient to identify anyone of its numbers – that is to distinguish it from all the others. Thus a line – straight or curved –has only one dimension, since its points (members) are identified by the values of a single parameter. Similarly, a surface – plan or curved – has two dimensions, since we need two parameters to identify a point on it. The physical space surrounding us has three dimensions. Let us apply this concept to classification.

Dimension in Enumerative Classification:

Number of dimension of subject: In an enumerative classification the number of dimensions of a subject is the number of characteristics used in arriving at it.

Number of dimension of a universe of subjects: In an Enumerative Classification, the numbers of dimensions of the universe of subjects is the number of dimensions of the subject having the largest number of dimension.

Dimension in Faceted Classification

Basic Subject

Dimension of Basic Subject: The number of dimension of a main subject is one the number of dimension of a basic subject is one more then the number of step of division used in deriving it from its main subject. For example, the dimension of the main subject mathematics is one and the dimension of the basic subject determinant is three.

Dimension of universe of basic subjects: The number of dimension of the universe of basic subject is the number of dimension of the basic subject having the largest number of dimension.

Isolate Idea

Dimension of an Isolate Idea: The number of dimensions of an isolate idea is the number of characteristics used in arriving at it.

Dimension of the universe of isolate idea: The number of dimension of the universe of isolate idea is the number of dimension of the isolate idea having the largest number of dimensions.

Just like basic subject, Ranganathan defined dimensions for compound and complex subjects also. Eventually he defined the number of dimensions of the universe of subject on the basis of dimensions of basic, compound and complex subjects.

Linear Arrangement of Subjects and its Necessity: The human mind is, after all, at a very early stage in its evolution. Although we can speak of many dimensions, it usually works, more or less in one dimension. Even mathematicians have to work "bit by bit along the line ". There may be exceptions; but most serious thinkers have to think out one thing at time in succession. In particular the documents in the stake in their main entries in the catalogue have to be in linear sequence. The search for any one document or its entry has to be made by scanning along the line. But the universe of subjects has many dimensions. Let us say, n dimension, where n is a large positive integer. The subjects in the universe of subjects have to be arranged in a line for the convenience of readers.

Mathematical Transformation and Mapping: To state this in mathematical terms, we have to transform the n-dimensional space into one-dimensional space. In other words, we have to map an n-dimensional

space on a one-dimensional space. This is the problem in classification.

Invariant Among Immediate-Neighbourhood-Relations:

Consider the five points spread out on a plane.

C B

A

D E

Here B, C, D and E each claim Immediate-Neighbourhood-Relation with A. Let us arrange all the five points in one line. Let us put A at the left end. Them there can be only one immediate-neighbourhood-Position after A.

$$\frac{X}{A}$$

We can give that position only to one of B, C, D and E and not to all. To which shall we give that position? In other words, which of the four Immediate-Neighbourhood-Relations should be kept invariant while arranging the five points along a line? Consider the points as subjects. This lays bare our inescapable problem in classification. It is a mischief created by the mathematics of transformation and mapping. if begin to ask which of B,C,D and E should be given the benefit of keeping invariant its immediate –Neighbourhood-Relation with A, the chances will be equal to all the four elements . This tantalizing problem attains colossal dimensions when we have to arrange millions of micro subjects.

The idea of *Infinity* and *Infinitesimal*

The name *Infinity* (symbol: ∞) is given to an abstract concept that describes something without any limit or very large in quantity or measurement. This concept is relevant in a number of fields, particularly in mathematics, physics and philosophy. In mathematics, *infinity* is referred as very large number, i.e. larger than the largest conceivable number. The earliest recorded thought of infinity was so long known proposed by Anaximander[22], a pre-Socratic Greek philosopher, who used the word *apeiron* which means infinite or limitless. The name of Zeno of Elea[22] (c. 490 BCE? – c. 430 BCE?), a pre-Socratic Greek philosopher of southern Italy is also remarkable who built the concept of mathematical infinity. He is best known for his paradoxes, which was described by Bertrand Russell as "immeasurably subtle and profound". The Indian mathematical text Surya Prajnapti[22] (c. 3rd–4th century BCE) classifies all numbers into three sets: enumerable, innumerable, and infinite. Each of these was further subdivided into three orders:

- Enumerable: lowest, intermediate, and highest
- Innumerable: nearly innumerable, truly innumerable, and innumerably innumerable
- Infinite: nearly infinite, truly infinite, infinitely infinite

In this work, two basic types of infinite numbers are distinguished. On both physical and ontological grounds, a distinction was made between *asaṃkhyāta* ("countless, innumerable") and *ananta* ("endless, unlimited"), between rigidly bounded and loosely bounded infinities.

European mathematicians started using infinite numbers in a systematic way in the 17th century. John Wallis[23] first used the notation ∞ for such a number, and exploited it in area calculations by dividing the region into infinitesimal strips of width in the order of $\frac{1}{\infty}$ Infinitesimal, it is another concept exists in contrast with the concept of infinity. In mathematics, infinitesimals are extremely small entities that are absolutely immeasurable. Actually, an infinitesimal entity is reckoned as dimensionless, i.e. just like a point that has only existence, but no dimension. It means an infinitesimal entity occupies no space. The word *infinitesimal* comes from a 17th-century Modern Latin coinage *infinitesimus*, which originally referred to the "infinite-th" item in a sequence. It was originally introduced around 1670 by either Nicolaus Mercator or Gottfried Wilhelm Leibniz. It may be stated in mathematical context that an infinitesimal number is a number which is smaller than the smallest conceivable number and beyond any feasible measurement, but still not zero in size, i.e. it has an existence. The lexical meaning of the word *infinitesimal* is *extremely small*. In mathematical context, *infinitesimal* thus may be reckoned as reciprocal of *infinity* $\frac{1}{\infty}$ and vice versa. Infinite number of infinitesimals thus results some finite quantity, which is measurable. Georg Cantor[24]

formalized many ideas related to infinity and infinite sets during the late 19th and early 20th centuries.
Let us examine the steps involved in Ranganathan's interpretation of *subject*.

Step 1: Infinite Universe
  Step 1.1: Complete Division

Step 2: Continuous Infinite Universe
  Step 2.1: Universe of points in a straight line
  Step 2.2: Universe of straight lines in a plane
  Step 2.3: Universe of points in a plane

Step 3: Universe of subjects and unitary class

In step 1, the infinite universe is defined with examples, for instance, universe of positive integers, or universe of points in a plane. It is also stated that the universe cannot be completely divided. In step 2, the infinite universe with all-pervaded entities has been designated as *continuous*, and the concept of *continuous infinite universe* is the precursor of the concept of subject. The examples of continuous infinite universe depicts the infinity within a finite frame, i.e. infinite numbers of infinitesimals. Actually, ∞ numbers of $\frac{1}{\infty}$ results some finite entity and this concept was used by Ranganathan in defining subject. The Newtonian concepts of limit and continuity are also based on such ideas of infinity and infinitesimal. The resemblance was cited in the examples like points on a line or plane. Actually, a point is a dimensionless entity with an existence that may be analogized with infinitesimal entity. Hence, a point may be analogized with a micro-subject or spot subject. Ranganathan categorized subject in different classes in accordance with sizes, i.e. macro subject, micro subject, spot subject etc. The spot subject as defined by him was a subject of very tiny extension and enormous intension that is usually embodied in a single sentence or even in a single word. This concept of spot subject may be reckoned as predecessor of the concept of subject-specific keyword. The picture exerted by number of points in a line or plane instantly recalls number of subjects in a concept space at per Ranganathan's approach. The extension of the concept space is finite, where the number of specific subjects existing may be infinite. This manifestation of infinite number of entities within a finite frame was also picturesquely expressed by Tagore[25] in a song:

(সীমারমাঝেঅসীমতুমিবাজাওআপনসুর,
আমারমধ্যেতোমারপ্রকাশতাইএতমধুর।)

O boundless, within bounds, you play your own tunes-
Hence, your light within me is so mellow.

In the third step Ranganathan asserted that the universe of subject is a continuous infinite universe, which should be the central theme of the idea plane. In the next step, Ranganathan defined parameters and dimensions of subjects and isolate ideas. He interpreted the characteristics of subjects as dimensions. The first two canons of *Idea Plane* are, *Canon of Characteristics* and *Canon of Succession of Characteristics*. The idea of dimension or characteristics of a subject is thus an important criterion for the idea plane. Different subjects may possess different dimensions. The relationship among different facets within a subject domain is also another manifestation of dimensions. Such effort is observed in developing ontologies of subjects. Representation of a multi-dimensional subject in terms of any notation or artificial language essentially needs transformation of the same into one dimension, as the alphanumeric notational symbols form an one-dimensional array. To develop a notational system the reduction of number of dimensions to unity is thus mandatory. Ranganathan explained this proposition in the topics entitled *Linear Arrangement of Subjects and its Necessity* and *Mathematical Transformation and Mapping.*

George Cantor and Ranganathan

Hjorland[24] pointed out that Ranganathan developed a theory of *the universe of subjects* inspired by the mathematical works of Georg Cantor (1845-1918) in relation to the idea of infinity. Ranganathan always used mathematical concepts and theories *as analogies* rather than working directly as a mathematician. His theory of the universe of subjects was that subjects exist in a multidimensional space. Ranganathan's theory of facet analysis appeared in *Prolegomena to Library Classification* in 1937 and was reissued in an updated version of this work in 1967. Ranganathan referred to such infinite sets of subjects by the term *facets* and he described two kinds of facets:

1) *Basic subjects*: Subjects which do not have isolate ideas as a component are basic subjects. Example: Mathematics (Ranganathan, 1967, 83).
2) Qualifications of basic subjects, which he termed *isolates*. They are, for example, space and time (In the example "Indian 20th Century Mathematics," *India* and *20th Century* are respectively space and time isolates).

Before Cantor, there was only finite set and the concept of infinite set was hitherto considered as a topic of philosophy rather than mathematics. Cantor established the set theory in modern mathematics in the sense that it interprets propositions about mathematical objects from all the traditional area of mathematics (such as algebra, analysis or topology) in a single theory. Cantor introduced the concepts of set of real numbers, set of natural numbers etc. He defined finite sets, subdividing the letter into denumerable sets and uncountable sets. He proved that there exist infinite sets of different sizes. For instance, the set of integers is countably infinite, while the infinite set of real numbers is uncountable. Ranganathan was influenced by Cantorian infinite set concepts and applied the same in developing theory of subject.

George Gamow and Ranganathan

Gamow[26] (1904-1968) was a Nineteenth Century Russian theoretical physicist and cosmologist. He was notable for an early advocacy of Lemaitre's Big Bang theory. He discovered a theoretical explanation of alpha decay via quantum tunnelling and worked on radioactive decay of the atomic nucleus, star formation, stellar nucleosynthesis, Big Bang nucleosynthesis and molecular genetics. He focused on teaching and became well known as an author of popular book on science, including *one two three ….Infinity*. This is a must read for all students, particularly science students. The way in which Gamow treated the concepts of infinity and infinitesimals in this book instantly recalls the same in Ranganathan's *Prolegomena*...The descriptions given in the chapters entitled *The number of points on a line, The number of points in a square* and *The first three infinite numbers* are highly analogous to Ranganathan's description.

Conclusion

Ranganathan's conceptual development of subject is a holistic attempt in library science. It is a fundamental description wherefrom the concept of knowledge organization originates. Ranganathan used mathematical axioms to define subject. As mathematics is the finest form of logic and reasoning, its involvement with a subject gives the fundamental picture of the same. The heart of the Colon Classification throbs with this basic viewpoint of *subject*. The book *Prolegomena to Library Classification* is the Bible for the both traditional library classification and today's knowledge organization through ontology, semantic web etc. Satija[27] pointed out very appropriately that *what Ranganathan recognized was that the world of knowledge was growing very quickly, with new areas of knowledge being discovered and new ways to combine existing subjects, and that any classification that attempted to enumerate a finite number of subjects without full capabilities for expansion to allow for new areas of knowledge could never meet the needs of the future*.

Glassel's[28] interpretation of Ranganathan in the context of modern information storage and retrieval is highly relevant. She remarked, *And yet just because a classification scheme wasn't widely accepted, this doesn't necessarily mean it didn't leave a lasting impression. This might describe the situation of Shiyali Ramamrita Ranganathan, a librarian from India who introduced the Colon Classification system to the world in 1933..... I am more likely to think of his theories as coming from a man ahead of his time. Consider how frequently the notion of "facet" is being mentioned in the literature today in connection with information storage and retrieval in an online environment. This comes full circle back to Ranganathan, who is credited with being the first person to apply the term "facet analysis" to classification (Navalani, p.124).*

According to Aluri et al. (p.132-33), there are three advantages of faceted classifications over enumerated ones:

1. *"The schedule of a faceted scheme takes up much less space than the schedule of an enumerative scheme with the same amount of specificity."*
2. *"Faceted classifications permit far more specific classification than do most enumerative schemes."*
3. *"Even before the advent of the computer, [faceted classifications] permitted a detailed form of indexing -- chain indexing -- which provides access to every facet of the combined notation."*

As I thought about these three advantages I became convinced that Ranganathan may have been a Yahoo!, which may not be a bad thing. Were he still living today I think he might be pleased to see how

information agencies still appreciate and are applying his ideas, especially with regard to the third point noted above.

Not only yahoo, or Google, or else, Ranganathan's basic theory of faceted classification based on his prime notion of *subject* may untie numbers of knots in the buzz and hubbub of today's chaotic online mess.

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