Principles for Helpful Sequence and Deduction of Knowledge Organization Systems - An Exploratory Study

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ABSTRACT

Dr. Ranganathan's "Principles for Helpful Sequence" among the set of normative principles play an exclusive role in the arrangement of subject isolates. Each subject in the universe of subjects is regulated by a guiding principle of its own which analogously determines the sequence of Arrays in ordering the subject surrogates or isolates. For example, the "Principle of Later-in-Evolution" is applied for sequencing isolates of Animal and Plant Species; this concept can be applied to one of the tools of KOS viz. *Taxonomies*. The application of Principles for Helpful Sequence is summarily presented and in the process the paper highlights the inherent elements of knowledge organization in each one of these principles in a manner that might map the future course of research in this area with the potentiality to bring about a relation between principles for helpful sequence and KOS.

Keywords: Library Classification, Principles for Helpful Sequence, Knowledge Organization Systems

1. INTRODUCTION

Among the numerous contributions of Dr. Ranganathan's to conform to scientific method in Library Science, two contributions are unique and notable. They are "Five Laws of Library Science," published in 1931, and the "Dynamic Theory of Library Classification," begun in 1935. There are two classificationists of the modern era, Dr. S.R. Ranganathan and Henry Evelyn Bliss, in addition to E.C. Richardson and

W.C. Berwick Sayers, who attempted to develop a theory for library classification (Parkhi, 1972). The theory developed by Bliss was a descriptive and static theory. The theory developed by Bliss remained quiescent, as further research in this context lacked organizational and professional support. Ranganathan's theory was based on a set of normative principles which served as theory for the design of a scheme for Library Classification and also for a set of Scheme of Classes. From this initiation he proposed a postulate of faceted classification and developed his theory accordingly, envisaging autonomy to classifier to develop the theory without expecting the classificationist's approval, as the latter has given exclusive basis for the developmental process. The purpose of this exercise is to identify KOS in an attempt to correlate them with the principles for helpful sequence. In this context the Postulates for Modes of Formation of Subjects can be quoted as an example. It is stated that this knowledge is a dynamic continuum and new disciplines and subjects will be deduced from this spiral of growth of knowledge. The new subjects are to be suitably accommodated in a Scheme of Classes to keep the Classification system up-to-date, and at the levels of Idea and Notational Planes, which can automatically be carried out by the classifier based on the 'typology of relations' characterized by the modes of formation of subjects. The case of Biochemistry might be exemplified here. Biochemistry is designated as a **Fused Basic Subject** and it would be assigned an exclusive notation of GX and its place is assigned between Biological Sciences (G) and Earth Sciences (H) (Ranganathan, 1987). A complete case study on the formation of Biochemistry is made by Gopinath and Seetharama (1975). A Scheme for Library Classification provides several guidelines for recognizing new and emerging subjects, for example Literary Warrant, and also for deciding on their location in the sequence of innate subjects.

A classification in general involves three processes:
1. Division and Grouping
2. Arranging the members of the group and the groups themselves in a helpful sequence
3. Representing the ranked members of a group by a suitable notation.

The theoretical basis of designing a classification system can be studied from the descriptive account of three planes of work viz. Idea Plane, Verbal Plane, and Notational Plane, the basic foundations of a dynamic theory of library classification. The guidance of work in the first stage of Classification, that is *Division and Grouping*, is the work of the Idea Plane and regulated by Canons (rules of division) and Postulates (rules for logical assumption). The work *of arranging the members of a group and the groups* as above is an exclusive task carried out with the help of "Principles for Helpful Sequence", which is the core discussion of this paper. The entire work of both developing a dynamic theory for library classification, and a set of normative principles was enunciated and evolved by Ranganathan (1967).

2. NORMATIVE PRINCIPLES

The definition of Normative Principle as given in Prolegomena is as follows:

> Normative Principles can be postulated for work in different levels from the level of the basic process of thinking, through the level of library science (or for any other discipline) as a discipline, to the level of each of its various sub-disciplines — such as classification and cataloguing and even still to the deeper levels (Ranganathan, 1967).

The word 'Normative' is derived from the root term 'norm', meaning rules or an authoritative standard. Normative means 'establishing a standard'. So the phrase Normative Principles refers to the principles of establishing standards for designing various tools, methods, and techniques of Library Science. So the basis of normative principles deals with establishing standards for developing a dynamic theory of library classification.

The entire work of the theoretical basis of designing a Classification can be visualized from the set of Normative Principles as shown in the following table.

As per the above table the Level "Classification" refers to division and grouping which is carried out with the use of Canons. The work on the Level classification dealt with by Canons from the core of the Idea Plane, in conjunction with contributions to this area, has also come from Richardson, Sayers, and Bliss. But the contribution to the Level Helpful Sequence in Array dealing with "Principles for

Table 1. Normative Principles

S. No.	Level	Name of Normative Principle
1.	Basic Process of thinking	Basic Laws
2.	Library Science	Fundamental Laws
3.	Classification	Canons
4.	**Helpful Sequence in array**	**Principles for Helpful Sequence**
5.	Work of Classifying	Postulates and Principles for Facet Sequence

Source: Ranganathan's Prolegomena to library classification, 1967. Part-D. P.113

Helpful Sequence" is work exclusive of dynamic theory. The application of these two levels would overcome the bottlenecks in the division and arrangement of the universe of subjects. This pronounced hypothesis can be demonstrated with examples from a discipline like Astronomy.

The discipline Astronomy was part of Mathematics till the sixth Edition of Colon Classification and has been assigned the status of an independent Basic Subject in the seventh Edition of the scheme with Class Number BX (Ranganathan, 1987). The Sub-disciplines of Astronomy are some "Known" and some "Unknown" cosmic bodies. Accordingly the subdisciplines of Astronomy comprise "Known" and "Unknown" entities. Then the known entities have to be arranged in some sequence, such as Alphabetical, Epoch of Origin, and so on. Which of these characterizations gives a helpful sequence for the present or for the future representations of Astronomical knowledge? The known astronomical bodies in this context are the Sun and the Nine Planets orbiting around the Sun. So here comes the problem of arranging these bodies. The Principles for Spatial Contiguity endorse the arrangement of isolates (bodies) in space along a unidirectional linear sequence and the "Principle of Away from Position" as one of the guiding principles applied in this context. The Principle of Away from Position is defined as:

> If the subjects in an array of subjects or the isolates in an array of isolates can be conveniently taken to start from a certain point and diverge away from it roughly along a line, they may be arranged from the starting point along the diverging line.

Here in the Astronomy subject all the planets in the orbit would be arranged beginning with the Sun at the Centre and the other Planets in the divergent line of their sequence of orbital paths. This is one of the simple examples that can be comprehended by everyone and has a majority agreement to this sequence of planetary bodies. Thus the set of Principles for Helpful Sequence (with their corollaries) regulating the sequence of sub-divisions of a discipline and to deeper finite levels.

3. PRINCIPLES FOR HELPFUL SEQUENCE

The Principles for Helpful Sequence are shown in the third level of the Normative Principles that deal with the details of the arrangement of the isolates in the schedules to be created by the division of subjects into sub-disciplines. These principles suggest that there should be some guiding principle to implement the "Canon of Helpful Sequence."

The 12 main Principles for Helpful Sequence with their manifestations as described by Ranganathan (1967) and Parkhi (1972) are given in Table 2. One and more Principles can be applied to a Discipline or to Sub-disciplines. For example, in Botany the Principle of Later-in- Evolution is applied for deriving the species of plant kingdom (Taxonomy) and then taking a Plant as an entity; to arrange parts of a Plant, the Principle of Bottom-Upwards is applied. A parallel example is also found for the Agriculture Subject Schedule (J- Agriculture) in Colon Classification for the arrangement of parts of a Plant as a parallel to Utility Array. Similarly in Medicine, for the parts of the

Human Body the Principle of Top-Downwards is used and for the Organs the Principle of Centre to Periphery is used.

Principles go in consonance with domain specific and logical ideas, which has facilitated the arrangement of groups of entities in a discipline and helped in bringing chaos to order along a natural and logical thinking process as part of "Basic Laws of Thinking"

from the first level of Normative Principles (See Table 1). It would also be presumed that without the guidance from the Principles for Helpful Sequence the arrangement of sub-disciplines in disciplines would have been too complex and tedious. Table 2 gives a set of such principles pronounced by Ranganathan in his theory with subject examples.

Table 2. Principles for Helpful Sequence with some examples

S. No.	Name of the Principle	Subject Example
1.	**Principles for Chronology and Evolution**	
	a) Principle of Later in Time	Religion
	b) Principle of Later-in-Evolution	Botany
2.	**Principles of Spatial Contiguity**	
	a) Principle of Spatial Contiguity	Geography
	b) Principle of Away from Position	Astronomy - Planets
3.	**Principles for Entities along a Vertical Line**	
	a) Principle of Bottom-Upwards	Botany - Parts of a Plant (From Root to Fruit)
	b) Principle of Top-Downwards	Medicin e- Parts of Human body (Starting from Head)
4.	**Principles for Entities along a Horizontal Line**	
	a) Principle of Left-to-Right	Transportation - Highway
	b) Principle of Right-to-Left	Transportation - Highway
5.	**Principles Involving "Front" and "Back"**	
	a) Principle of Front-to-Back	Railway Train
	b) Principle of Back-to-Front	Time isolates - earliest to recent
6.	**Principles along the Circular Line**	
	a) Principle of Clockwise Direction	Zodiacal Signs
	b) Principle of Counter-Clockwise	No. specific example at present. If warranted the Principle will be used.
7.	**Principles for Entities along a Radial Line**	
	a) Principle of Periphery-to-Centre	Layers of Earth
	b) Principle of Centre-to-Periphery	Medicine - Organs (Bone to Hair)
8.	**Principles Involving Quantity**	
	a) Principle of Increasing Quantity	Mathematics - Geometry
	b) Principle of Decreasing Quantity	Library Science - Libraries
9.	**Principle of Increasing Complexity**	Linguistics - Alphabet to Sentence
10.	**Principle of Canonical Sequence**	Mathematics - Basic divisions of Mathematics
11.	**Principle of Literary Warrant**	Agriculture: Arrangement of Crops
12.	**Principle of Alphabetical Sequence**	Automobiles- Car Brands

4. KNOWLEDGE ORGANIZATION

4.1 Analogy of an Indian Tradition

When we talk of knowledge and its organization, social and cultural realities serve as useful analogies to explain the former precisely. Incidentally it would be desirable to understand what is knowledge and the related aspects of knowledge organization. Let us take an example from an Indian traditional practice:

It is a common practice and a tradition in India in all functions and celebrations, to light a lamp. The basic philosophy of this practice as per vedic saying is **"Tamaso ma jyotirgamaya"** (From darkness lead me to light) and it means from ignorance to knowledge. A lit lamp as per Indian tradition signifies "Knowledge". (Raghavan, 2012).

As per the general theory of order outlined by Diemer (1974 as cited in Dahlberg, 1978) there are three aspects to everything:

    a) The point of view of a totality

    b) The point of view of an element or elements

    c) The point of view of relations between the elements

If a lamp is conceived of as a totality, its parts as its elements and each element are ordered according to the elemental relationship between the elements and/or parts of the lamp. The application of one of the Principles for Helpful Sequence viz., the "Principle of Bottom Upwards" can be applied to arrange the parts or elements of the lamp. This is precisely what can be conceived of as an analogy to exemplify knowledge organization and how knowledge organization can be conceptualized where all components of the lamp are assembled systematically to construct a lamp post. In furtherance of this analogy other tools of knowledge organization like ontologies are also inherent in the form of the "wick" and "oil" essential to characterize a lighted lamp. A "Lit Lamp" would thus be taken as an analogy to exemplify the relationship between Knowledge and Knowledge Organization.

The significance correlating *Lamp* with KO is to identify the elements of knowledge and the lit lamp in order to consider a holistic approach to understand knowledge and its organization with the following attributes:

    · The characterization of Knowledge

    · The elements of Knowledge (the Lit Lamp and its parts, the oil/ghee, the wick)

    · The purpose of Knowledge (the Lit Lamp dispels darkness, knowledge does away with ignorance)

    · The properties of Knowledge (light) (the upward direction of the flame conceived as vices (Vasanas) and ego, imparting knowledge, increasing clarity, conviction)

    · The organization of Knowledge (Lamp) has significance to know a wealth of intellectual and spiritual perceptions from it.

    · The oil or the ghee represent the vices (vasanas) and wick the ego.

4.2. Knowledge Organization: Conceptual Basis

In the presentation of the ideas in this discourse, a bottom-up (inductive reasoning) approach is adopted to expound the complexities of knowledge and knowledge organization (KO). Both concepts are hard to explain and no precise definition could be articulated. Some simple and descriptive account of KO is given here, extracting from various sources.

In simple terms KO as a discipline is defined as the organization of information in bibliographic records. On the other hand, Dahlberg (2006) states that:

> "Knowledge organization is the science of structuring and systematically arranging knowledge units (concepts) according to their inherent knowledge elements (characteristics) and the application of concepts and classes of concepts ordered by this way for the assignment of the worthwhile contents of referents (objects/subjects) of all kinds".

The lit lamp illustrated above would be an explanatory example for this definition. More precisely Dahlberg (1998 as cited in Ohly, 2007) defines "knowledge organization as a subject area comprising the organization of a) units of knowledge concepts and b) all types of objects related to particular terms or categories, so as to capture what is known about the world in some orderly form allowing it to be further shared with others". The two definitions stated in two different periods of time themselves show contrastingly different intents of knowledge and its organization.

The descriptive account of knowledge organization

given by Hjørland (2008) is much more distinct from the above two definitions. He considered KO on two levels to define and deliberate its scope and application. The narrower sense of KO is applied to mostly LIS activities such as classification, indexing and cataloguing, and so on. In the broader sense of the term, he states that it is applied to organization of knowledge in educational institutions, social organizations, and he describes how it is organized in the reality of sciences, like in Chemistry, Biological Sciences, Linguistics and Geography, and so on. It is further explained that in chemistry the periodical table is the taxonomic visualization of chemical elements and the family of languages would be another taxonomic presentation in the context of linguistics. These, according to him, are the realities in sense of their organization.

It is further emphasized by Hjørland (2008) and Miska (1964 as cited in Hjørland, 2008) that KO has been a practical activity, as the classification schemes devised in the late nineteenth century are continued to be used. It is remarked by Hjørland (2008) that "genuine theoretical bases to KO are very rare but seem mandatory in relation to the challenges with which this field is confronted." This paper is a pursuance attempt to characterize the Dynamic Theory of Library Classification formulated by Ranganathan has qualities to make it a "genuine theoretical base" both for the practical library classification activity and to the KO, as Classification schemes are also one of the Knowledge Organization Systems. It is important that theoretical assumptions based on different practices have to be used to formulate these assumptions as clearly as possible in order to make comparison possible. As a matter of fact, the "educational consensus" approach adopted by Henry Evelyn Bliss has some good elemental issues relating to modern KOS as much as the postulatonal approach adopted by Ranganathan. Thus a consolidation exercise of integrating some good theoretical bases from the classic to modern periods has to be done to formulate a KO theory.

Ranganthan did do an exercise to develop the dynamic theory independent of a single practical classification scheme, and used Colon Classification only to affirm his assumptions. There is a base for considering the dynamic theory that can be applied to KO both

in its narrower and broader sense and meaning. For example, the use of the "Principle of Literary Warrant" of Wilhelm Hulme (1911 as cited in Hjørland, 2008) is evidence of its application to KO in broader meaning. Another argument in favoring this argument is taken from Hjørland (2008) again, where he has identified six approaches to study KO and has enlisted the "faceted analytical approach" as one of them. The faceted approach has provided a methodology of "modes of formation of subjects" and it is how new knowledge is formed or formulated by combination of a priori existing knowledge/disciplines.

4.3. Knowledge Organization Systems

The practical Library Classification schemes are the traditional and also most durable systems of KO. Bliss, in the titles of his two books, probably was the first to use the phrase "Knowledge Organisation" in relation to bibliographic classification. The lists of Knowledge Organization Systems (KOS) vary to some extent from author to author. The paper by Lei Zeng (2008) is used here as a basis for the enumeration of KOS. The types of KOS according to the complexity of their structures and major functions can be grouped and listed below:

* **Term Lists**
  · Lists (pick lists)
  · Dictionaries
  · Glossaries
  · Synonym Rings
  · WordNet

* **Metadata-like Models**
  · Authority Files
  · Directories
  · Gazetteers

* **Classification and Categorization**
  · Subject Headings
  · Classification and Categorization Schemes
  · Taxonomies

* **Relationship Models**
  · Thesauri
  · Semantic Networks/Maps
  · Ontologies

4.4. Deducing KOS from Principles

The application of the dynamic theory of library classification evolved by Ranganathan has been reflected in the study of Faceted Classification models and categories. This paper has ventured to use another normative principle of the theory "Principles for Helpful Sequence" to demonstrate their applications in the tools and components of KO viz. KOS.

The core object of this paper therefore is to demonstrate how the Principles for Helpful Sequence can be employed to derive a helpful order in the tools for KOS such as Ontologies, Gazetteers, Taxonomies, Term Lists, and so on. This is probably a first attempt in this direction and has provided a superficial indication of their applications for further exploration.

a) On Ontologies

Among the above KOS tools the LIS is quite familiar with the majority of them and has been applying them effectively in the traditional and web-based knowledge organization of bibliographic records in libraries (Catalogue, OPAC) and in bibliographic databases (Bibliographies), Online databases, and in other sources of bibliographic records such as Abstracting and Indexing Services, and today even in the databases of electronic information resources. So the term Ontologies is somewhat unfamiliar and un-comprehended in its application in KOS. Therefore the term is explained in its nouveau context:

> "In philosophy ontology is a theory about the nature of (things) existence; of what type of things exist; Ontology as a discipline studies such theories. Artificial Intelligence (AI) and Web researchers have co-opted the term for their own jargon and for them Ontology is a document or a file that formally defines the relation among the terms. The most typical kind of ontology for the web has taxonomy (Web-pages) and a set of inference rules (In Expert Systems/AI)".

For instance, Expert Systems which are by-products of AI consist of an inference engine which is built on a set of ontologies (inferring relationship among terms).

It is obvious that most of the Principles for Helpful Sequence are built on relationships among different terms and concepts. A body of knowledge is based on conceptualization and the object concepts and other entities that are assumed to exist together inherently are in relationships among them that hold them together.

Two examples in this context would illustrate the above intricate summations on the role of ontology in KOS. In the subject Medicine (in CC) the human body is divided into its component parts and is arranged on the **"Principle of Top - Downwards"** from head to toe. Here the terms and concepts are arranged according to their inherent relations and to hold them together to conceive a body (Physical Appearance).

Another example in the same subjects where the diseases are ordered follows as per the schema shown below:

Illustration - 1:
Disease> Organ (affected) Facet> Incident of Disease (Kind) > *General/ Infection /Parasite / Poison/ Functional disorder/ Nutrition/ Structural/ Foreign Matter/ Other*

Here the body of knowledge of "Diseases" is presumably categorised based on the *"Principle of Increasing Complexity"* and also the *"Principle of Literary Warrant."* In other words, these principles would be under consideration for the future incidence of organizing diseases. The relationships between the Organ (Affected) and the kind of incidence of disease are nothing but ontologies. This can be illustrated by the example of a Disease like "Typhoid":

Illustration - II
TYPHOID>Intestine (organ affected) >(Incidence-1) Infection>Bacterial (Incidence-2> Number of cases (Literary Warrant)

b) Taxonomies

Genealogy is a part of Taxonomies, and Genealogy is of ideas and objects. The best example in this context is the use of the *"Principle of Later in Time."* The first vacuum tube, the predecessor of the microprocessor, was invented by John Ambrose Fleming in 1904 and later it proceeded to the development of the Microprocessor. The genealogy of Vacuum Tube to Microprocessor with dates is presented in the follow-

Table 3. Genealogy of Microprocessor (Intel - 4004)

Idea	Product	Person(s)	Year
Photoelectric Effect	Electric/Vacuum Tube	John Fleming	1904
Solid State or Semi-conductor device or / Silicon Chips	Triodes and Diodes	Bardeen, Brattain and Shockley	1947
Integrated Circuit	IC Chip	Kilby and Noyce	1958
Microprocessor (Intel- 4004)	Single Micro Chip	Intel (Faggin, Hoff and Mazor)	1971

ing table (Table 3).[6,7,10,18]

c) Gazetteers

Gazetteers as the formal sources of geographic information have been in the list form and in a form giving a descriptive account of place names, their locations, latitudes and longitudes, and other related features. They also provide information on rivers, mountains, oceans, and other geophysical entities and concepts. Every Library Classification scheme since the time of DDC has a separate and exclusive scheme of classes for Geographical Isolates (as in CC) and Areas (as in DDC). So they have been an integral part of KOS and in particular of Library Classification Schemes. The maps, atlases, and encyclopedias have been sources of Gazetteers apart from the independent Gazetteers of nations, like the Gazetteer of India. The scope of gazetteers ranges from the smallest geographical areas to international levels.

In recent years Gazetteers have been regarded as indispensable tools with the advent of Geographical Information Systems (GIS) and the Global Positional System (GPS). There are new courses instituted under and designated as Geoinformatics. This shows the importance of Gazetteers as KOS. The utility of Gazetteers in Georeferencing is well documented and substantially highlighted by Buchel and Hill (2010).

The *"Principle of Spatial Contiguity"* specifies the mode of developing a helpful order for Geographical entities and concepts. The Principle states "If the isolates (Subdivisions) in a schedule occur continuously in space—roughly along a unidirectional (North-South, East-West) line or radial line or a circle they should be arranged in a parallel spatial sequence, except for when any other overwhelming consideration rules it out.

d) Lists, Authority Files, Subject Headings

This category of KOS consists of quite a large number of tools which are mainly the vocabulary tools of languages. In this group the authority files need some special attention as building authority files is a continuous and never ending process. The authority files may be for terms, concepts, names of places, or names of persons, and they are the tools used both in KO and in KM in particular in Content Management Systems. The metadata is one of the authority files which are used in KM and CMS.

Two Principles, *"Principle of Literary Warrant and Principle of Alphabetical Sequence"* are the ones which provide guidance for the compilation and consolidation of term lists by gathering new terms to update tools like glossaries and dictionaries. It is stated that the alphabetical sequence eliminates all ambiguities in ordering the concepts and terms.

The Authority Files are associated with the vocabu-

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laries to update them. When new terms are identified, old terms are replaced with new terms giving more comprehensive scope and coverage. For example, Ecology and Environment, Genetics — Microbiology and Biotechnology are terms with inclusive meaning and definitions of old concepts. So the principle of literary warrant governs the socialization of such new terms. Normally the arrangement of Authority files follows the alphabetical sequence and the Principle of Alphabetical Sequence is applied here for the arrangement of terms, particularly in Subject Headings.

e) Other KOS Tools and Principles

Among the given Principles the utility of the majority of them is presented with suitable examples from KOS and some illustrations too. The other KOS systems like Thesaurus, Subject Headings, Semantic networks, and Classification and Categorization schemes have been formally well articulated with their long term use in the organization, representation, and search and retrieval process. In fact the Classification schemes have a very basic foundation of knowledge organization and have demonstrated their predominance in them too.

A Thesaurus for example shows some very concrete relations among terms — equivalent, associative, and hierarchical. These relationships have been part of organizing vocabularies in the Vocabulary Control Devices per se the Thesaurus, which is one of the predominantly researched areas in Semantic Web. A beginning is made to venture on a new application of a dynamic theory of library classification and attempts by researchers may be made to carry out further explorations in this direction.

5. CONCLUSION

The discipline of knowledge organization, though well discussed now in the web environment, has its roots in the times of Aristotle, Comte, and Kant, who created philosophical systems of knowledge then extant. Based on their contributions later classificationists tried to develop a theory for Knowledge Organization, in the limited sense of Library or Document Classification, for facilitating shelf arrange-

ment. In the subsequent decades these also served as a basis for subject cataloguing, indexing, and thesaurus construction, from Cutter to Ranganathan. Hence the traditions of Library Classification also conceived as KOS have potentialities to augment their basis for the development of a theory for KO and in this paper a small beginning is made. It can also be repeated here that KOS have also considered Facet Analysis as one of the techniques suitable not only for the classification of documents but has been proved suitable for structuring Website construction as demonstrated by La Barre (2006). So it could be concluded that there is enough ground for the development of a systematic and stable theory for knowledge organization from the traditional and classic library classification discourses of years past.

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