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Similarity Between the Ranganathan's Postulates for Designing a Scheme for Library Classification and Peter Pin-Sen Chen's Entity Relationship Approach to Data Modelling and Analysis

Madan Mohan Kashyap

Abstract

This paper describes the theoretical framework of Ranganathan's postulates for designing a scheme for library classification and Peter Pin-Sen Chen's entity-relationship approach to data modelling and analysis techniques to see the similarity between their concepts and applications, in their respective domains. It also emphasises the importance of Ranganathan's postulates in organising and searching the World Wide Web resources.

1. INTRODUCTION

We find that there is a similarity between the Ranganathan's Postulates for Designing a Scheme for Library Classification and Entity-Relationship Data Modelling Concepts stated by Chen, Peter Pin-Sen. These technologies are further modified by other experts. Both of the theoretical approaches are concerned with the organisation of information and apply almost similar theoretical principles, concepts, and techniques for effective organisation and retrieval of information in their respective domains. Postulational approach to classification based on a set of postulates or the principle of facet analysis and synthesis formulated by Ranganathan can be applied for (a) designing a facet scheme of library classification, (b) classifyng and organising documents possessed by the libraries in a helpful classified order, and (c) organising records of the bibliographic items as library catalogues to enable the library users to search and identify the bibliographic items of their interest through various access points.[1-2] The Entity-Relationship [ER] data modelling technique is used to specify a conceptual model of a database or to formulate a data structure design to organise the data or data records about a real world entities (such as animal, plants, documents, people, etc.).

This paper describes the theoretical framework of Ranganathan's postulates for designing a scheme for library classification and Peter Pin-Sen Chen's entity-relationship approach to data modelling and analysis techniques to see the similarity between their concepts and applications, in their respective domains.

Both of these theoretical approaches in our view are complimentary and supplementary and are used as means for designing, developing and searching databases of all types of organisations, including libraries.

We find that the faceted classification systems and subject indexing systems based upon Ranganathan's postulational approach or faceted analysis technique have been found, in some respect, superior to other techniques of online retrieval of information from the databases of information systems. This point of view is demonstrated by Godert[3] by three

examples, the first one is based on a short classification system derived from B. Bachnan, the second is built upon the classification system used by Library and Information Science Abstracts (LISA), the third example is concerned with some possible consequences which could be derived from retrieval with PRECIS strings. Ellis and Vasconcelos[4] have also pointed out the continuing relevance of facet analysis as a technique for searching and organising World Wide Web based documents. They argue that facet analysis, which is essentially a concept based approach to indexing is an excellent approach to searching and organising the WWW resources rather than using either search engines or search directories. Finally, they argue that the underlying philosophy of facet analysis is better suited to the disparate nature of WWW resources and searches than the assumption of current IR research. Neelameghan in one of his paper indicated that "the process of developing the conceptual schema, which involves identifying, delimiting or description of various entity-types, their attributes and the relationships among them and mapping them on to a data model is similar to the process of designing a scheme for knowledge or subject classification by Ranganathan. "[5-7]

2. ENTITY RELATIONSHIP (ER) APPROACH

The (ER) approach as a data analysis and modelling technique was first introduced by Chen, Peter Pin-Sen, in 1976.[8-9] Since that time, many experts in the field of information technology have suggested several modifications to the ER model.[10-14] It has presently evolved into one of the most important data analysis and database design technique. Database design is fundamentally a task in data modelling and a data model is architecture for data. It describes the general structure of how data is organised. The purpose of data analysis is to represent data as it is perceived by its users and referred to as semantic modelling technique.[15]

This database modelling approach is an analytical technique, which is based on three fundamental concepts namely: (i) Entities, the objects or things about which one wants to keep data or fact in a database, (ii) Attributes which represent the properties of the entities, and (iii) Relationships, which represent the association between entities and the entities acquire or possess certain attributes or properties due to their relationships with other entities. These concepts are the foundation of the ER model, with the help of which we can outline a conceptual model (also called logical view) of a database. The conceptual level model or design of a database relates to the representation of that part of the real world that the database is about.

Prior to the introduction ER approach, data requirements of an enterprise were determined by analysing the processes, transactions, outputs, or data flow of a system, or data element presumed to be needed by users, or by examining forms, files, reports of the enterprise or organisation whose computer-based information system was being designed.

ER approach pre-empts, identifying and describing of the real world, that is the universe of the enterprise or problem area, that is the objects or things associated with it, whose database is to be built. This approach was based on the assumption that examining only processes, transactions, outputs, or data flows of a system, or examining of all factors gives partial of the environment. Without a proper understanding of entities, objects or things themselves and their environment, one can not make reasoned decisions as to what data was needed about those objects or things.

2.1 ER Approach for Building Databases

ER approach helps us to get true or complete picture of the real world or universe whose database is to be built and involves:

(i) Identification and definition of entities of the concerned real world - the problem area or of the enterprise,

(ii) Entity grouping and description, and

(iii) Enterprise or problem area context

Each of these steps are explained below:

2.1.1 *Entity identification and definition*

This step involves recognising various entities whose database is to be built, determining why they are important to the organisation, researchers or users of database, and naming them.

2.1.2 *Entity grouping and description*

This step involves grouping of entities of interest (i.e., the given population) into broad and narrowly. defined classes, identifying, describing the relevant attributes of the entity-types (or entity classes) for creating the records of entities in the given context.

Each group or class, broad or narrow, constitutes of a number of entities that have a set of attributes in common. Thus, the entity description consists of identifying which attributes of an entity-type (or entity class) are relevant for creating the records of entities in a given context.

Broadly, we can group entities around us into persons, organisations, things, places, events, etc. However, these groupings are too general to handle in meaningful manner. Therefore, we must form subgroups of each of these classes into subtypes, i.e., into different kinds of people, things, places, etc., for ease of handling. The categorising of entities may be based on criteria, such as, what the entities are, what purposes they serve, what they do, how they look like, how they are used, etc.

The entities sharing common attributes are grouped together and form a class. In other words, an entity class could be considered as an aggregation of attributes. Similarly, an entity or object could be considered as an aggregation of its properties. Selecting appropriate differentiating attribute(s) or characteristics does the further division of entity classes into sub groups. The cannon for characteristics and cannon of succession of characteristics of Ranganathan[16] are helpful in this process.

One has to specify the recognised entities and entity groups and subgroups at the exact level of precision that ensures that it not so general as to be meaningless, and yet not too specific. For example to consider 'person', as an entity-type, to be of importance for creating a database of library system, would be too general or broad, as it can be fragmented into too many subsets. Where as, to consider 'Library Users', 'Library Employees' and so on, as the entities of interest is more precise and relevant selection. On the other hand, to consider 'Temporary Members' and 'Permanent Members' as entities of interest would be too specific, particularly if member of each group is given equal status or privileges according to the rules of a library system. In this case, 'temporary' and 'permanent' are the attribute or status of a user, and can alternate between the two positions and still user having is equal status.

It is sometimes necessary to divide entity-types into sub-groups. For example, Professional Staff, Semi-professional, Non-professional Staff might all be declared as subtypes of entity-type Library Employee. Like wise Library Manager, Deputy Library Manager, and Assistant Library Manager would be declared as subtypes of the entity-type Professional Staff. While forming groups of entities, it is necessary that we attempt to use the most general, yet most meaningful, grouping possible. The important consequence of forming generalised hierarchy of entities or entity groups or classes is that - entities lower down the hierarchy inherit the attributes and relationships of entities higher up in the hierarchy. Hence, a deputy library manager would inherit attributes of deputy library managers in general, and of employees in general. Likewise, a deputy library manager would inherit the relationship of a library employee to a department.

The broad group of an entity set or the first level group is called family or super-class. Each super-class or family constitutes of subgroups, and the groups higher level can be further subdivided in subgroups. (The term - type and subtype is also used in place of group and subgroup, respectively). Each subgroup within the family or super-class has a common characteristic that differentiates it from other groups of the family, and shares all the attributes of the family as whole. (A

characteristic is some property or attribute that distinguish one thing from other).

An entity, entity family, entity-type or group is defined within the context of the organisation or the library system whose database is supposed to be built. Thus, an entity belonging to a broad group in one context may belong to subclass/subgroup/subtype of entities in another context.

Entity groups, at family level and below, are primarily formed based on role which member of each group plays in the organisation. Further, the entity grouping may be created in the form of a mutually exclusive (disjoint) type of subclasses or mutually inclusive (partially disjoint or overlapping) type of subclasses.

In some instances however, an entity can play a multiple role. For instance, a member of a university library system can be a teacher, a student, and a library staff member. In real world, a teacher, a student, and a library staff member belong to mutually exclusive sub classes. In case the library rules do not provide equal loan facilities or other privileges to the members each group, then in this case, each group must be treated mutually exclusive group. However, if member of each group is given equal status or privileges according to the rules of a library system, then though the roles of each entity-type or group are distinct in the context of university set up, all these entity groups be merged in one family type - Library Member. Their roles (as teacher, as student, or staff member) may however be treated as their attributes. The subgroups of entity-type Library Member, namely Teacher Member, Student Member, and Employee Member are to be treated as its overlapping or mutually inclusive subclasses.

While classifying entities into families (super classes), groups and subgroups, the following factors need to be kept in mind:

(a) If the roles are mutually exclusive, i.e., if the entities can play one role in the organisation and not other, define separate entity families, groups, or subgroups.

(b) If the roles are distinct, but not mutually exclusive, merge the entities into a single entity family or a broader group.

2.1.3 Enterprise Context

Enterprise context involves identifying and defining the relationships that exists between the identified and defined entities, their relative importance to the enterprise as a whole, and each specific part/sub-unit/subsystem of the enterprise. The enterprise or problem context also involves identifying the role or function of each of the entities or entity-types within the enterprise or organisation. For example, the Entity-type 'bibliographic item' has different perspective in the context of a library system in comparison to its association with a business enterprise (e.g., publisher). The specific description of bibliographic entities and their relationships with other entities within a library system are relevant only within the context of the library system.

2.2 Entity Relationship (ER) Diagrams

Entity models are usually mapped out as entity-relationship diagrams (ER diagrams). The product of entity-relationship diagramming is a model of entities (objects of interest), the relationships between entities, and attributes associated with entities in some domain of discourse. An ER diagram illustrates the data to be stored in an information system, which constitutes a database of the information system. The data to be stored in a database pertains to an entity or a set of entities in real world, sometimes called the mini-world. The data about an entity are essentially the values of its attributes (or attribute set) and their relationships with other entities, that is the attributes the entity acquires or attains due to its relationships with other entities. Relationships represent connections between entities and meaningful dependencies between them.

An entity or an entity-type (i.e., the object set about which one wants to keep data or fact in a database) is represented on a diagram by a rectangular box in which written the meaningful name for entity. A relationship between entities is represented by drawing a line (some time labelled) between relevant entity boxes, on the diagram. An attribute is represented an oval attached by a line to the appropriate entity. The entity identifier (attribute) is underlined.

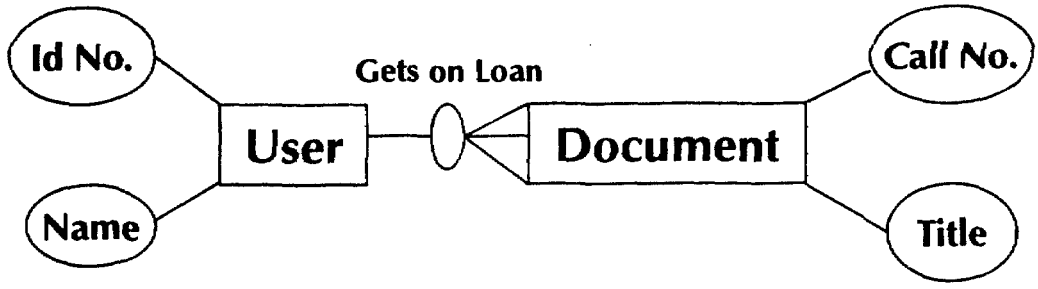

Figure 1. An illustration of ER Diagram

ER diagrams show data at rest, i.e., data being stored or to be stored in the proposed system, independent of how that data will eventually be processed or used. ER diagrams complement data flow diagrams or flow charts, which show data in motion i.e., as data flows. System analysts use this tool to develop implementation-independent data models, which allow them communicate with end users in non-technical language. The implementation-independent models are usually called conceptual, logical or essential models. The conceptual model (also called conceptual or logical view of a database) is a concise description of the data requirement of end user or users of computer-based information system. It describes the various entity-types, their attributes and the relationship between them.

The conceptual schema might be regarded as an over all logical database description or a global model representation of a database as conceived by the library database administrator or systems analyst and is entirely independent of physical storage organisation of a database. A conceptual schema can be defined using ER model concepts and can be displayed by means of the graphical notation.[17,18]

An ER diagram is conventionally referred to as a conceptual model of a database system. From this conceptual model, we derive an implementation-dependent logical model (expressed in the form of as a series of tables structured in third normal form for a relational database system), which may be mapped on to or converted into the database structure of a Database Management System (DBMS). The final step in database development is to produce a physical model. That is, a series of record structures expressed in the syntax of some programming language or DBMS.[19]

A database conceptual schema is specified during database design of an information system and is not expected to change frequently.

3. DEFINITIONS OF KEY CONCEPTS OF ER APPROACH

3.1 Entity

An entity or object is defined as anything (physical or abstract) in the real world about which one wants to keep data, facts or store descriptive information in a database record. An entity may be a tangible object with physical existence, such as, a particular person, an employee, a library member, a book, a serial, a chair, or a table. It may be a non-tangible object with conceptual existence or an abstract concept, such as, an event, a transaction, a job, a procedure, a subject of study, or a university.

All entities are distinct from one another in the sense that each possesses a particular set of properties, attributes or values those distinguish it from the others. Thus, a bibliographic item has properties such as title, size, price, cost, etc.; a library user possesses attributes such as name, age, educational qualification, place of residence, etc.; and a library employee has attributes such as name, address, basic salary, etc.

The entities may exist in large homogeneous groups where all members are capable of being described in the same manner having identical attributes, or they may be fragmented or considered into many subtypes, each with a description which are either slightly different, or

in some cases radically different, from the other members of the same group.

We contrast or differentiate between entities, for some purpose, based on some characteristic or characteristics, even if in the real world they are from the same class of objects. For example, library members and library employees are both persons, but library member is a person who makes use of library collection, while library employee is a person who organises and maintains the library collection for the use of the library members. A monograph and a serial are both bibliographic items, but a monograph is a non-serial bibliographic item (i.e., it can complete in one part or finite number of parts, or intended to be completed in a finite number of parts), but a serial is a periodical publication or bibliographic item published/issued in successive parts bearing numeric and/or chronological designations and intended to be continued indefinitely. Each part is generally made up of distinct and independent contributions, not forming a continuous exposition.

The manifestation we referred to above as entities can be called entity-types (or entity classes) because each denotes a set of objects (individual entities), each of which exhibits the properties/attributes described for the class and about which one may be interested in collecting facts or data for use. An entity-type is a category and an entity, strictly speaking, is an instance of a given entity-type. The data collected about an entity is descriptive data about attributes of the entity. Thus, the entity-type 'library member' is made up of individual entities, each of which has attributes, name, age, and educational qualification, place of residence, etc. Every individual entity belonging to this class possesses all the attributes of the class but differ from one another in the values of data elements or items associated with their attributes.

3.2 Attribute

An attribute is a characteristic, a property, or a fact of an entity, entity class or entity-type, and a set attributes describe an entity or entity-type. An attribute associated with an entity or entity-type can be intrinsic or natural, such as 'size' of a book, or extrinsic (or associative, assigned to it or acquired by an entity due to its relationship with another entity), such as 'written-by', 'accession number' of a book. An attribute may also describe, why a relation exist, how long it will exist or has existed, or under what condition it exists.

The value of an attribute of an entity provides a piece of information or elementary data about an entity or about its relationship with other entities. Title, for example, is the attribute of the entity bibliographic item (a monograph, a serial or an article), and so is edition, date of publication and extent. From the values of attributes: title, date of publication, extent, bibliographic item, type, etc., we can identify a particular bibliographic item, know whether the item is a monograph, serial, or component of a serial or composite monograph. A string of symbols used to represent an attribute of particular entity is called a value of the attribute. Thus, 2nd ed., 1998 and xx+200p are the value of the attributes - edition, year, date of publication, and extent respectively, of a particular book.

A value of an attribute is often divided into elementary parts or units called data elements. For example, we represent the attribute name of an author is into following parts (or data elements) - entry element, other part the name, role, etc. Thus, a defined attribute of an entity-type has one or more data elements associated with it.

3.3 Relationship

A relationship represents associations or connections among the entities. In real world entity does not stand-alone and acquires certain attributes due to its relationships with other entities, or due to actions performed on by other entities or agents those bring changes in its state or conditions. A particular bibliographic item in a library, say a monograph is written by an author(s), published by a publisher, sold by a vendor, is bought by a library, is classified by a staff member, etc. Each of these is an example of a relationship, a logical connection between two or more entities. For example, the terms 'written by' and 'edited by' show relationship between the entity-types MONOGRAPH (i.e., a published work of an author) and the AUTHOR. Thus, we can say that the name of

author or editor of a 'Monograph' is the attribute acquired by an entity 'Monograph' because of its association or link with the entity 'Author'. It may be pointed out that relationships exist only between entities, not between attributes of entities.

3.4 Domain of Attribute

To facilitate the correct construction and efficient operation of a database, we not only recognise and define the entity sets with which we are concerned, their relevant attributes, but also state the domain of each attribute. The set of valid values of an attribute is called the domain of the attribute. For example, a designer of a bibliographic database system must make decisions about matters, such as: (a) what elements of information about the bibliographic items to include—the name(s) of the principal author(s), the name(s) of collaborator(s), title, edition, so forth? (b) how to determine who is the principal author of the work? (c) whether an author's name should be recorded as it appears on the document, or should be recorded in the form described or restated in an authority file, and so forth.

4. RANGANATHAN'S POSTULATES FOR DESIGNING A SCHEME FOR LIBRARY CLASSIFICATION

According to Ranganathan, library classification is concerned with "classification of subjects or universe of subjects."[20] A subject is the theme of a work, an organised or systematised body of ideas, facts, data, or information concerning some thing or things, or exposition of theoretical construct(s) embodied in a bibliographic item. The content of a bibliographic item is product of intellectual, transintellectual, creative activity or imagination of man recorded in an intelligible, coherent and communicable form. The focus of study and description in a work or document can be about a conceptual (abstract) or concrete (physical) entity or entities, or their properties. A subject of study is itself something created by man that encompasses a body of knowledge about some thing or things and is governed by a set of fundamental laws, hypothesis, postulates, and principles.

A work comprises the thought contents, information, or knowledge contained in a document or package of information, plus the language in which the thought contents are expressed or communicated. A work is equal to thought contents, which is soul of a document and language or any other means of communication of thoughts, which is subtle body of a document.

4.1 Definition of Document

Ranganathan defines a document as "record of a work on paper or other material, fit for easy physical handling, transport across space and preservation through time". The term 'Document' includes any bibliographic item or the record of any kind of work—macro or micro—and the physical embodiment is exclusively of one work or is shared by more one than one work. It constitutes of subject (i.e. thought contents, knowledge, information, or message it holds), plus language (communication medium or thought channel), and plus recording material (paper, electronic media—tape, disk, and so forth).[16] The subject is the soul of a document, language subtle body, and recording material represent gross body of a document.

He defines entity as "any existent, concrete or conceptual, that is, thing or idea." Any entity has distinct personality comprising of a set of characteristics or attributes. An attribute being "any property or quality or quantitative measure of an entity."[21]

If we perceive or know about the attribute or attributes possessed by an entity or entity set we know about it or them. We can also distinguish one entity or entity set from another because of certain characteristic(s) or attribute(s) possessed by one and not by other. For example, we know that the entity tree is distinct from the entity timber. Because we know that for a living tree it is essential that its root to be in soil and for its branches to have access to water, light and air. The 'tree-ness' (the personality of tree) of living tree is distinct from the dead tree as 'timber' or 'wood'. If soil, water, light and air are removed, there can be no tree left and it turns into timber or wood. The 'tree-ness' of tree is energy (water, light and air) depended and tied to matter (soil). Further,

a tree or specific type of tree can exist in certain conditions and places, or live up to certain time. Thus, 'tree-ness' of tree is related to matter, energy, space and time in specific way and none of these elements can be excluded from it. The description of the properties of the tree, its relationship with or dependence on water, soil, air, light and specific environmental conditions, and that it exists in particular place, and live up to certain time, provides us knowledge or information about the entity tree, or portrays its total personality.

Soil, water, air, light, place and time are also entities in their own right, having their own personalities that are distinct from the entity tree. Tree is living thing; where as soil, water, air, light are non-living physical things. Space and time, per se, are conceptual entities.

Ranganathan divided the universe of knowledge into traditional 'basic subjects' or 'main classes of subjects' followed by a sub-division of these basic subjects or classes through the application of 'trains of Characteristics' or 'facets'. The term 'facet' refers to a manifestation of any one of the five fundamental categories - Personality [P], Matter or Property [M], Energy or Action [E], Space [S] and Time [T].

4.2 Postulates for Designing a Scheme for Library Classification

The set of postulates formulated by Ranganathan for designing a scheme for library classification as well as classifying the bibliographic documents according to their specific subject put the theory of classification, and the work of classifying and indexing the bibliographic documents on firm scientific basis. These postulates or principles of facet analysis and synthesis were first time formally stated by Ranganathan in his paper presented to the International Study Conference on Classification for Information Retrieval, held at Dorking in 1957.[22] Though, the explicit statement of the postulates or principle of facet analysis and synthesis was first time made by Ranganathan in his paper presented to the Dorking Conference, yet these were actually applied by him, implicitly, in designing his Colon Classification Scheme published in 1933.[23] The fourth edition of Ranganathan's Colon Classification is the first version of Colon Classification, whose design is based on his explicitly stated postulates or principles for facet analysis and synthesis for library classification, which were first time stated by him in paper presented at the International Study Conference on Classification for Information Retrieval, held at Dorking in 1957. Ranganathan, later incorporated these postulates, somewhat in an elaborated form, in his Prolegomena of Library Classification. Edition 2.[24] The enunciation and application of the postulates became more sharpened, clear and simple in his later works, particularly Prolegomena of Library Classification. Ed. 3.[16]

One of the major contributions of Ranganathan in the field of Library and Information Science is chain procedure, the first version of which was published in 1939.[25] It is a subject indexing technique to derive subject headings from a class number mechanically. The method is based upon Ranganathan's theory of symbiotic nature of classification and cataloguing.

Ranganathan was of the view that once the class number of a bibliographic item is determined on the basis of a classification system, the specific subject heading of a document can be derived by verbal interpretation of class number and consequently deriving other related subject headings for a subject catalogue, with the help of the chain indexing technique. However, later he suggested that specific subject heading of each bibliographic item can be derived independent of a class number based on the 'Postulates of Facet Analysis'. In Ranganathan's own words: "the postulates for facet analysis and principle for Facet Sequence are as much help in finding out the names of the Subject Heading, as they are in establishing its Class Number. The tasks of cataloguing and of classifying are equal beneficiaries of these postulates and principles. The use of one and the same procedure in cataloguing and classifying does not warrant the assumption of subject heading being derived from class number or class number being derived from

subject heading, of two different branches say A and B of one and same tree, we do not say either A stems from B or that B stems from A."[26]

4.2.1 *Postulates of Different Kinds of Subjects*

Ranganathan postulated that a subject of a work or a document can be Basic Subject, Compound Subject or Complex Subject, that is, three types of subjects exist namely: Basic, Compound, and Complex Subject.

Basic or Simple Subject

A subject without any isolate idea or concept as a component is called a basic or simple subject. A basic subject represents a field of study, a discipline or sub-discipline (branch of learning, e.g., Algebra) or any aggregate of fields of studies (e.g., Mathematics), mutually exclusive and totally exhaustive first order array of subjects of a scheme for classification. A basic subject forms the Basic Facet of a compound subject. It encompasses a body of knowledge that is concisely governed by a set of fundamental laws, hypothesis, postulates, and principles. Mathematics, Arithmetic, Algebra, Biology, Botany, Cytology, Social Sciences, Political Science, Literature, Sanskrit Literature, Physics, Space Physics, Logic, etc. are examples of basic subjects.

According to Ranganathan, "if a work or document contains overall description of an entity or an entity set, which are the central theme of a work, or contains an exposition of a theoretical concept or concepts about some phenomenon/phenomena or thing(s) then the subject of the work is deemed to be of type simple subject."

Compound Subject

A compound subject is a subject having a basic subject (basic facet) and one more isolate ideas or concepts (isolate facet) as its components. For example, each of the following subject statement or title of a monograph indicates that the subject matter of the monograph is compound subject. Examples of compound subjects: **Mining** of ***gold***, **Chemistry** of ***gold***, **Biological study** of ***animals***, **Botanical study** of ***flowers***, ***Treatment*** of **cancer** in **Ayurvedic System** of **Medicine**, represent compound subjects. (The terms in bold letter represent the basic subject or facet and a term in bold and italics represents an isolate idea or facet of the compound subject). Each Isolate facet/idea of compound subject is manifestation of one of the five fundamental category.

According to Ranganathan "if in a work or a document, one describes only part or portion of the personality of an entity or an entity set, or gives description of one or some attributes possessed by an entity or entities, and/or actions on it by or through other entities, in a particular space and time context, then the subject of the work is deemed to be of type compound subject."

Ranganathan postulated that make up of a compound subject constitutes of one or more five mutually exclusive fundamental categories: Personality [P], Matter [M] or Property, Energy [E] or Action, Space [S] and Time [T]. This set of fundamental category for brevity denoted by initionym PMEST. He also introduced an extended version of these in the form of levels and rounds of their manifestations.

Complex Subject

A complex subject is two or more phased subject. It is represented by a subject statement which shows some relation (e.g., bias, comparison, influence etc.) between two or more simple subjects or compound subjects, for example: Physics compared to Chemistry or Psychology for Doctors.

According to Ranganathan, "if in a document or a work deals with or contains description of interrelationship, comparison, etc. among two or more basic subjects or compound then such a subject of the work or document is deemed to be of type complex subject."

Postulates of Isolate Idea or Concept

An Isolate Idea (or concept) is any idea or concept which itself cannot deemed to be subject but fit to be a component of a compound subject or complex subject. Isolate concepts or terms such as: Gold, Animal, Child, Air, Flower, Cell, Hardness, Goodness, Red, Blue, etc. do not convey us any meaning unless

we associate them with some basic subject. Further, each isolate idea of a compound subject is deemed to be manifestation of one and only one of the five fundamental categories of ideas, defined below:

4.2.2 *Postulates of Five Fundamental Categories*

There are five and only five fundamental categories of isolate, concepts or ideas namely, Personality (Entity), Matter (Attribute or Property), Energy (Action), Space, and Time. An isolate idea or concept belongings to any one of these five fundamental categories.

The fundamental category (FC) 'Personality', 'Matter', 'Space' and 'Time' can manifest many hierarchical levels or may comprise of facets of different levels.

The FC 'Energy' may manifest itself in one and same subject more than once. The first manifestation of the FC 'Energy' is taken as end of round one of the manifestation of the three fundamental categories 'Personality' [1P], 'Matter' [1M], and 'Energy' [1E]. The second manifestation of FC 'Energy' is taken to end round two (represented by symbol [2E]), followed by [2P], [2M], [2E], and so on.

An isolate idea belonging to the fundamental category 'Personality', 'Matter', 'Space' or 'Time' may pertain to any one of the hierarchical level of the category.

PERSONALITY [P]

The fundamental category 'Personality' [P] is the most crucial or essential category among the five categories. There was time when many scholars in the field of library science, particularly western scholars, felt that "Ranganathan has not attempted strict definition of personalities."[27-28]

It appears that Ranganathan chose the term 'Personality' to represent the focal point of description or key object or objects of study or description in a work. A basic subject or domain of study is concerned with the study and description of a conceptual or physical object or a set of objects. The domain of study Botany is concerned study and description of plants (found in nature). Physics is concerned with physical phenomena - Heat, Light, Sound, etc. Medicine - Human body, and its organs. As Dahlberg[29-30] points out "man is always concerned with two realities:

(a) Entities or being, such as inanimate beings (e.g., gold, earth, water, and so on), animate beings (plant life, animals life), divine beings and mental beings, and

(b) Predications (known/established facts) about the entities or beings, i.e., determinations of beings."

Correspondingly, Ranganathan divides the subjects dealing with the various kinds of entities, that is, the living or non-living natural beings (systems), or the material, intellectual, cultural, and spiritual products of man and society, into different 'Basic Classes' or 'Subjects'. Further, he postulated that the study and description of the subsets of entities, including their parts, constituents, or organs, etc., falling within the domain or perview of a 'Basic Class' or 'Subject' (i.e., a field of study or any aggregate of fields of study) are deemed to be the component of the 'Personality' facet of that 'Basic Class' or 'Subject'. Where as, the predication about, or perceptions of entity-types, or the description of discovered, established or known attributes or facts about the entity types or their subsets falling within the domain or preview of a 'Basic Classes' or 'Subject' are deemed to be the component of one or more of the remaining four facets or fundamental categories—Matter (Property), Energy (Action), Space and Time. It appears that the Ranganathan picked up the terms for these four fundamental categories from the domain of physical sciences.

The category 'Personality' or 'Personality Facet of Compound Subject' stands for as any physical or conceptual entity or entity set, object or object set, phenomenon or phenomena or theoretical construct(s) about which facts, information, explanation, knowledge, or mental images as formed in the mind of a person, and described or embodied in a work or a document. When we collect and outline or explain facts about an entity, we actually give description about its whole personality or part personality, i.e., we describe its attributes, character, nature, relationships with other entities (i.e., influence, impact,

control, etc. on it, of or by some other entity or entities), or its interaction or symbiosis with some other entity or entities, as well as about its being present or existing in certain space-time context.

MATTER (Attribute or Property) [M]

The isolate ideas or concepts representing the intrinsic matter, material, properties, attributes, of entity /object or entity/object set, that is, qualities, quantities, functions, activities, processes, growth, change of state, behaviour or characteristics of entities or objects belong to this category. Morphology, Defect, Disease, Colour, Inflammation, Reliability, Weight, State, Harmony, Authority, Constitution, Structure, Hardness, etc. are some examples.

ENERGY (Action) [E]

The category 'Energy' (or Action) covers the isolate ideas or concepts that represent the attributes attained or acquired by the focal entity due to its relationships with other entities, or action, operation (mental or physical) or impact on a the focal or core entity (i.e., the object or thing affected by action on it, by or through another entity), which brings change in the property or characteristics of the entity. This category demarcates isolate ideas or concepts of the attributes relating to the energetic actions or interactions that may take place among and by all kinds of entities — inanimate, animate, conceptual, intellectual and initiative.[21]

Isolate concepts such as Measurement, Treatment, Evaluation, Diagnosis, Calculation, Critical Evaluation, Control, Influence, Impact and so forth belong to this category. As pointed out earlier that the fundamental category Energy may manifest itself in one and same subject more than once. The first manifestation of the fundamental category (FC) 'Energy' is taken as end of round one of the manifestation of the three fundamental categories 'Personality' [1P], 'Matter' [1M], and 'Energy' [1E], which is followed by second round of 'Personality' [2P], 'Matter' [2M], and 'Energy' [2E], and so on. For example, the result (value) of measurement (action) [1E] is the property [1M] of an entity or object [1P] measured with the aid of yardstick or instrument/tool/agent of measurement [2P], another entity. It may be observed that the concept of relationship as defined by the ER modelling approach has correspondence with the Ranganathan's postulational approach. In the example, we find that the tool of measurement (entity) has relationship with the entity being measured and the result of the connection is the finding of the specific value of the attribute possessed by the entity measured.

SPACE [S]

The category 'Space' denotes concepts, isolate ideas such as geographical location, or place where the entity resides, or where some event or action takes place in relation to an entity or entity set. Location of an entity is also a distinctive property or attribute of an entity.

Examples:

Geographical Space - Continents - Asia, Countries - India, Districts, etc.

Population Clusters - Cities, Towns and Villages, etc.

Physiological Formations - Mountains, Deserts, Rain-Forests, Rivers, Lakes, etc.

Water Formations - Oceans, Seas, etc.

TIME [T]

The category 'Time' includes isolate ideas or concepts, such as, Millennium, Century, Decade, Years, Day, Night, Winter, Rainy day, Dry day, Hour, Second and so on. Presence or existence of an entity in specific time is also its distinctive property or attribute of an entity.

CONCLUDING REMARKS

As can be seen from above presentation that the theoretical approach of defining the conceptual level schema or an over all logical database description of an information system of a problem area is related in characteristics to the theoretical approach of Ranganathan for designing a scheme for subject or knowledge classification. Ranganathan, also recommended that the work of designing a scheme for subject classification may be divided into three planes of work - idea plane, verbal plane, notational plane. Neelameghan[6] points out that "this approach can also be applied usefully to the designing of databases. The major steps in the

Table: Steps of designing a database and designing a scheme for subject classification

	Designing a database	Designing a scheme for subject classification
	Idea Plane	**Idea Plane**
1.	Identifying data entities (objects about which data is to be collected)	Identifying/defining the subject domains for which scheme for classification is to be designed
2.	Selecting attributes of data entities of interest to potential users	Selecting attributes of the entities constituting the subject
3.	Selecting data model, a schema to map the entities and their attributes	Selecting classification model (hierarchic, faceted, freely faceted) for mapping information about the *entities* (concepts /isolates)
4.	Grouping/dividing the data entities by their common attributes and differentiating attributes (characteristics)	Grouping/dividing the concepts/isolates by their *common attributes and differentiating attributes* (characteristics)
5.	Organising, arranging the groups, subgroups, and units derived at step 4	Organising arranging the groups, subgroups and isolates derived at step 4
	Verbal Plane	[Work on the *Verbal Plane*]
6.	Naming fields and data elements	
	Notational Plane	[Work on the *Notational Plane*]
7.	Assigning tags to fields, coding, etc.	

three planes of work are again similar as shown in above mentioned table:

Library classification and indexing systems based upon the theory of knowledge classification of Ranganathan or his facet analysis and synthesis approach are formal devices, which have been used very effectively for organising the documents in helpful order (i.e., according to APUPA arrangement,[26] and indicate their subject matter with a purpose of identifying the documents on specific subjects and related subjects available in a library). Facet analysis and synthesis approach of Ranganathan (also called concept based indexing approach) can also be effectively used to organise and search huge volume of information being generated on the Internet or on the Web (or the WWW), the multimedia part of the Internet.

The utility of using facet analysis to organise and search WWW resources is well demonstrated by Ellis and Vasconcelos.[4] They also point out that "if Ranganathan were alive today he would be aware of the potential of his ideas for searching and organising WWW material. Indeed, the genius of Ranganathan is attested to be the very portability of his ideas across time, technology and culture, simply because they address the very foundation of effective information storage and retrieval.

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Contributor: *Prof.* Madan Mohan Kashyap retired as Professor from Dept of Library & Information Science, University of Delhi. His residential address is 201 Kadambri Niwas, Kadambri Marg, Sector-9, Rohini, New Delhi-110085. Tele: 7862699 (R); e-mail: kashyap1@indiatimes.com