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Systems Approach in the Study of the Attributes of the Universe of Subjects*.

(Universe of subjects. 2).

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[Study of the structure, modes of formation, and patterns of development of the universe of subjects and its components, and the establishment of methodologies for such a study, are pre-requisites for the formulation of guidelines for the design and development of document finding systems. In studying the attributes of the universe of subjects and of its components it is helpful to consider a subject as a system. The general systems approach can be helpfully applied to the study of the attributes of the universe of subjects. These points are discussed with illustrative examples.]

A Scope of the Paper

A knowledge of the structure and development of the universe of subjects forms the foundation for the design and development of document finding systems. Therefore, the study of the attributes of the universe of subjects and the formulation of methods for such study should form core subjects in courses on the design and development of document finding systems (27, 31).

This paper attempts to show that the systems approach — specifically, deeming a subject as a system — is helpful in studying the attributes of the universe of subjects as a whole and of individual subjects forming its components.

B Idea and Subject

B1 IDEA

An idea is the product of thinking, imagining etc., got by intellect, by integrating with the aid of logic, a selection from the apperception mass, and/or what is directly apprehended by institution, and deposited in the memory.

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B2 SUBJECT

A subject is an organised or systematised 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 specialisation of a normal person.

C Three Correlated Universes

C1 UNIVERSE OF ENTITIES

The universe of entities or knowees consists of all known entities and of all knowable entities. The universe of entities is, therefore, practically limitless, tending to infinity.

C2 UNIVERSE OF IDEAS

Human intellect, ever since the evolution of *Homo sapiens*, has actively and continuously been engaging itself in knowing about the components of the universe of entites. An idea is generated when a knower knows an entity — that is, knowee. Thus, a stream of ideas has been flowing and accumulating constituting the universe of ideas. The totality of all ideas preserved by civilization at a particular point of time constitutes the universe of knowledge. Thus, for each known entity in the universe of entities there is an idea-correlate in the universe of ideas and the universe of knowledge. The latter universes are both ever-growing and dynamic.

C3 UNIVERSE OF SUBJECTS

The totality of all the sets of systematised body of ideas — that is, subjects — constitutes the universe of subjects. Thus, for each subject in the universe of subjects there is a set of idea-correlates in the universe of ideas. The universe of subjects is also ever-growing and dynamic.

D Structuring of Subject Aids Communication

The organisation of the component ideas in a subject into a structured pattern aids communication, learning, and remembering. As Jerome Bruner writes: "Grasping the structure of a subject is understanding it in a way that permits many other things to be related to it meaningfully. To learn to structure, in short, is to learn how things are related. Perhaps the most basic thing that can be said about human memory, after a century of intensive research is that unless detail is placed into a structured pattern, it is rapidly forgotten" (10).

Selections from the universe of subjects form inputs to document finding systems. The subject of the reader's query also tends to be organised into a structural pattern. In searching

in the document finding system to select subjects matching the subject of the reader's query, the organising capacity of the brain has an important role to play. As Patrick Meredith puts it: " The brain is a spatial structure and although the intake of information is a process taking time the information itself is stored in the space of the brain. Each item of information contains a multitude of clues which link it to other items. These links need not form one-dimensional chains but can be organised into networks. The brain has an insistent tendency towards organisation and, if left to itself, will pull together the most scrappy and disorganised material into some sort of pattern " (26). Or to quote Kenneth Boulding: " We cannot regard knowledge as simply the accumulation of information in a stockpile, even though all messages that are received by the brain may leave some sort of deposit there. Knowledge must itself be regarded as a structure, a very complex and frequently loose pattern, almost like an enormous molecule, with its parts connected in various ways by ties of varying degrees of strength" (9).

E Foundational Study

It is obvious, then, that a study of the structure and development of the universe of subjects, including the modes of generation of subjects, is a pre-requisite for the design and development of document finding systems.

F Subject and System

F1 System

A system is a set of inter-related elements, each of which is related directly or indirectly to every other element, and no subset of which is unrelated to any other subset (2).

A purposeful system has a goal or objective.

F2 Subject Re-defined

Expressed in terms of the definition of a system, a subject (*See* Sec B2) can be redefined as a set of interrelated component ideas, each component idea being related directly or indirectly to every other component idea of the subject. Considered as a purposeful system the objective of organising a body of ideas — that is the process of building up a subject—is to facilitate communication and understanding or grasping the meaning and message conveyed by the set of ideas.

F3 Environment of a System

A system has an environment — that is, a set of elements and their relevant properties, which elements are not part of the

system, but a change in any of which can cause a change in the state of the system (3).

F4 ENVIRONMENT OF A SUBJECT

For a given subject, the environment consists of all the subjects of the universe of subjects excepting itself. We have already noted that the universe of subjects is a subset of the universe of ideas, and that the latter, in turn, is a subset of the universe of knowees. Thus the changes in the universe of ideas affect the attributes of the universe of subjects. And the changes in the universe of subjects affect the attributes of any one subject forming a subset of the universe of subjects.

F5 CHOICE OF PARTICULAR CONFIGURATION

In a given context and at a given moment of time, a system together with its environment makes up the universe of all things of interest at that moment to the enquirer. Ultimately it depends on the intentions of the one who is studying the particular universe as to which of the possible configurations of entities is to be chosen as the most helpful to him (19). This factor has a direct bearing on the structuring and arranging of subjects to meet effectively the enquiries of knowledge-seekers.

G Helpfulness of Considering a Subject as a System

The discussions in Sec F1 to F5 indicate that there is an explicit parallellism between the definition of a system and the definition of a subject. Therefore, one can consider the attributes of a system in studying the attributes of subjects. Further, the techniques of system analysis and other methodologies developed for the study of the attributes of different kinds of systems can be considered for use in the study of the attributes of subjects. As an illustrative example, the application of some of the approaches of General Systems research used in the study of attributes of systems, to the study of the attributes of subjects, is discussed in the succeeding sections.

H General Systems Theory and Its Technique

H1 DEFINITION

General Systems Theory according to Bertalanffy, Lazlo and others, is concerned with the study of properties and principles of systems (or wholes) in general, irrespective of the nature of a particular system or its components. The models and principles formulated from such a study are intended to be applicable to different systems occurring in various disciplines (5, 25).

H2 Study of Common Attributes

One of the techniques of General Systems research, according to Kenneth Boulding, is to examine the " empirical universe and to pick out certain general phenomena which are found in many different disciplines, and to seek to build up general theoretical models relevant to these phenomena". The main objective is to develop a framework or structure of systems with the help of which the structure of particular disciplines can be related in a helpful sequence of coherent corpus of knowledge, thus enabling a specialist in one discipline to receive relevant communications from those in other disciplines (8).

For example, the following phenomena and attributes are observable in diverse systems:

1 Population—that is, aggregates of individuals conforming to a common definition, to which individuals may be added and subtracted, and in which the age of the individual is a relevant and identifiable variable;

2 Growth— for example, in crystals, organisms, social institutions etc;

3 Entropy;

4 Interaction of individual with its environment;

5 Feedback and control — for example in machines and organisms; and

6 Homoeostasis.

H3 Structure and Development

H31 *Strategy of Enquiry*

Rapaport (43) points out that General Systems Theory is primarily concerned with the structure of systems as defined by the inter-relation among the components of the system, the dynamic behaviour of the system in its different states as determined by the inter-relation among the components, and with the development of the system as a result of the interactions between it and its environment. Implied in this definition is that the formulation of a General Systems Theory requires:

1 Recognition of the types of components of different systems;

2 Determination of the degree of inter-relation among the sets of components of different systems; and

3 Study of the modes of development of systems, so as to formulate a generalised model of systems.

H32 *Facet Analysis*

Facet analysis is a generalised technique for the recognition of the components of a system and for studying their inter-relation

with reference to the overall objective of the system. The components can be re-combined in different ways establishing different relations between them and studying the efficiency of the system in achieving its objective. The components can also be presented as a matrix of ideas, so as to indicate the gaps and unexplored areas in the universe of ideas. Thus, facet analysis, as a method of structuring ideas into patterns, is a helpful tool in system analysis and in the design and development of systems.

As an illustrative example, an extract from Dror's work (14) on the use of facet analysis for the study of Alternative Domestic Political Futures (= ADPF) is given below.

"The facet analysis should permit construction of a large number of imaginary ADPF through the combination of various subfacets. Some of these imaginary ADPF are theoretically impossible because of inherent behavioral or logical contradictions. The remaining theoretically possible ADPF serve as a basis for the various cross-impact analyses and predictions."

Formats for Facet Analysis of Domestic Politics and Its Use for Identification of ADPF.

Illustrative Format for Facet Analysis of Domestic Politics

Primary Facet	Subclassification into Secondary Facets, Tertiary Facets, etc.
1 Units of Sovereignty	By size: global to city By population By number of nations, cultures, races, etc. And more
2 Ideology	By intensity By various dimensions, such as right-left, tough-soft, inner-outer directed By substantive contents And more
3 Degrees of Pluralism	By types and numbers of decision centers By forms of interdependence And more

Primary Facet	Subclassification into Secondary Facets, Tertiary Facets, etc.
4 Cohesion and Consensus	By homogeneity *vs* heterogeneity By social distance By extent and form of internal violence And more
5 Mass Participation	By subject matter By modes (e.g., elections, opinion polls, etc). By significance And more
6 Elite Structure	By recruitment base and succession rules By rate of change of recruitment base and succession rules By turnover By homogeneity *vs* heterogeneity And more
7 Size of Political Activities	By number of persons directly involved By costs By perceived attention And more
8 Social Functions	By social function By degree of control By detailedness of interference By mode And more
9 Formal Structure	By various traditional classifications, such as presidential versus parliamentary, multiparty versus single party etc.
And more	

H33 *Some Attributes of System*

Feibleman and Friend have examined the commonness of structure and function in empirical organizations (Systems) to serve as an instrument for the study of such organisations at different levels. On this basis they have

1 Identified the elements of relations which may exist between the components of a system;

The elements of relation enumerated include:

Transitivity	Multiplication
Connexity	Commutation
Symmetry	Association
Seriality	Distribution
Correlation	Dependence
Addition	

2 Formulated rules of organization in terms of which the components and their inter-relations can be studied;

3 Identified the kinds of organization constituting degrees of integrality of system;

4 Examined the nature of interaction of system with its environment; and

5 Formulated rules explicating the relation of static behaviour to the dynamic behaviour of systems (15).

The organizational laws formulated by Bertalanffy relate to the following attributes of systems (6, 7):

Wholeness	Finality
Sum	Equifinality
Centralisation	Growth in time
Differentiation	Relative growth
Leading part	Competition
Closed and open system	

Other properties of system studied by various authors including Khailov, Hall and Fagen, and Koestler, include the following (11, 24).

Coherence	Concurrent segregation and systematisation
Independence	Hierarchy
Progressive segregation	
Progressive systematisation	

Among the more recent works relevant to the discussions in this paper are Churchman's *Design of inquiring systems* (12) and Ackoff and Emery's *On purposeful systems* (1).

J Universe of Subjects and Document Finding System

The efficiency of an information retrieval/document finding system depends, in a large measure, on the depth of analysis, co-

extensive classification, and helpfulness of the sequence of arrangement, of the subjects forming the input to the system. It also depends on the depth of analysis, and coextensive classification of the subject of the reader's query at the moment and devices available for matching the latter with the already analysed subjects in the system to any predetermined degree of precision. The efficiency of analysis coextensive classification and arrangement of subjects in a helpful sequence is dependent on a knowledge of the attributes of the universe of subjects. In particular it implies:

1 Recognition of the organised bodies of ideas — that is, subjects — that form fields of specialisation of normal intellectuals;

2 Recognition of the degree of filiation among the fields of specialisation;

3 Recognition of the types of component ideas of subjects falling in the different fields of specialisation;

4 Recognition of the modes of combination and the nature of relation among the component ideas in different subjects;

5 Studying the modes of development of subjects; and

6 Setting up of a generalised model for structuring of all subjects.

It is evident that the interest and approaches of the designer of an information retrieval/document finding system to the study of the attributes of the universe of subjects are similar to the interests and approaches of the formulator of General Systems theory to the study of the attributes of systems (*See* Sec H3 in particular).

In the succeeding sections illustrative examples of the incidence of some features of General Systems approach implied in the study of the structure and development of the universe of subjects are given.

K Variety of Ideas

K1 Three Primary Types of Ideas

At the phenomenal level, the number of ideas describing entities is very large. And it is an evergrowing universe. Ideas combine to form subjects. A study of the ideas forming components of the large variety of subjects in the universe of subjects indicates that the large variety can be categorized into three types. These are:

Basic subject idea;
Isolate idea; and
Speciator idea.

K11 *Isolate Idea*

An Isolate idea is an idea or idea-complex fit to form a component of a subject, but not by itself fit to be deemed to be a subject (38).

K12 *Basic Subject Idea*

A Basic Subject idea is a subject without any isolate idea as a component. Basic subject ideas are enumerated in the Schedule of Basic Subjects in a Scheme for Classification of subjects (34).

K13 *Speciator Idea*

A speciator idea when combined with a Basic Subject idea or an Isolate idea produces a change in their respective connotations. In this sense a speciator is a Modifier (4).

K14 *Combination of Ideas*

A combination of a Basic Subject idea with one or more speciator ideas is a Compound Basic Subject.

A combination of an Isolate idea with one or more speciator ideas is a Compound Isolate.

A subject consisting of a Basic Subject idea only is a Simple Subject.

A subject consisting of a Basic Subject idea and one or more isolate ideas is a Compound Subject.

Two or more subjects — simple or compound — studied in mutual relation to each other gives rise to a Complex Subject.

K2 SEVEN VARIETIES OF ISOLATE IDEAS

The large variety of Isolate ideas occurring in diverse subjects can be categorised into seven types (40). There are:

SN	Isolate Idea denoting	Manifestation of the Fundamental Category
1	Time	Time
2	Space	Space
3	Action	Energy
4	Method	Matter
5	Property	
6	Material	
7	Totality of all attributes of an entity taken together	Personality

Diving deeper to the near-seminar level, the seven varieties of Isolate ideas mentioned above can be reduced to five types by deeming each of them as a manifestation of one and only one

of five Fundamental Categories (40) as indicated in column 3. There is a similarity between Ranganathan's Five Fundamental Categories and Whorf's hypothesis on language (45).

L Modes of Combination of Ideas

L1 Enumeration of the Modes

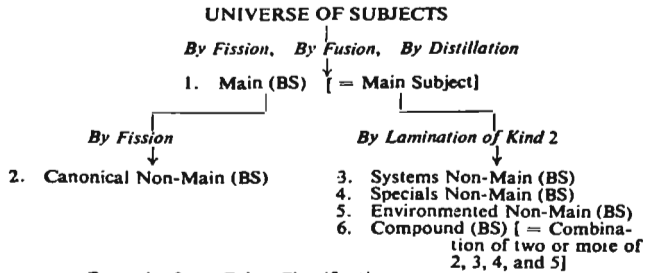
The following modes or patterns have been recognised in the formation of diverse subjects by a combination or by division of ideas (30).

1 Fission
2 Lamination of Kind 1
3 Lamination of Kind 2
4 Loose Assemblage
5 Fusion
6 Distillation

L2 Incidence of the Modes

L21 *Formation of Basic Subject*

The incidence of the modes in the formation of (BS) of difference kinds is indicated below:



Examples from Colon Classification

SN	Type of (BS)	Class Number	Name of (BS)
1	Main (BS)	C	Physics
2	Non-Main (BS)		
21	Canonical (BS)	C2	Properties of Matter
		C3	Sound
		C5	Light
22	Systems (BS)	C–N	Relativity Theory
23	Specials (BS)	C–9B	Nuclear Physics
24	Environmented (BS)	C–9H2	Low Pressure Physics
25	Compound (BS)	C–N–5	Relativity Theory of Light
		C–N–9B	Relativity Theory of Nuclear Physics
		C–N–9H2	Relativity Theory of Low Pressure Physics

(BS) = Basic Subject NA = Not Applied. Yes = Applied

Mode of formation	(BS) Main (BS)	(BS) Non-Main (BS)	Isolate	Compound subject	Complex subject	Relation or bond between components
Fission	Yes Traditional main subject only	Yes Canonical (BS)	Yes Array isolate	NA	NA	Fission or Chain rel/bond
Lamination of Kind 1	NA	NA	NA	Yes	NA	Facet rel/bond
Lamination of Kind 2	NA	Yes 1 Systems (BS) 2 Specials (BS) 3 Environmented (BS) 4 Combination of two or more Non-main (BS)	Yes	NA	NA	Speciator rel/bond
Loose Assemblage	NA	NA	NA	NA	Yes	Phase rel/bond
Fusion	Yes Fused main subject	NA	NA	NA	NA	..
Distillation	Yes Distilled main subject	NA	NA	NA	NA	..

L22 *Formation of Subject*

The following table summarises and indicates the incidence of the different modes in the formation of different variety of subjects — Basic Subject, Compound Subject, and Complex Subject. The nature of the relation or strength of bond among the combining components is also indicated.

L3 FORMATIONS AT THE DOCUMENT LEVEL

In addition to the above-mentioned modes of formation of subjects, at the document level "Partial comprehension" and "Subject bundle" formations have been recognised.

L4 STRENGTH OF BOND

Each mode of combination represents a relative difference in the strength of bond among the component ideas concerned. For example, consider the subjects going with a particular Main Subject such as Physics:

1 The subject "Physics for Biologists" is a complex subject, resulting from a Loose Assemblage between "Physics" and "Biology." The relation or bond between the two subjects is a phase relation/bond.

2 The subject "Physics of Sound" is a Canonical Basic Subject, resulting from the Fission of the Main Subject "Physics." The relation or bond between "Physics" and "Physics of Sound" is a Fission or Chain relation/bond.

3 The subject "Propagation of Sound" is a Compound Subject, resulting from the Lamination of Kind I of the isolate "Propagation" with the Canonical Basic Subject "Physics of Sound." The relation or bond between the Canonical Basic Subject and the isolate is a Facet relation/bond.

The Phase bond is the weakest; the Fission bond is the strongest; and the Facet bond is of intermediate strength. Thus, the three subjects will get arranged in the following sequence of increase in strength of bond;

Physics
Physics for Biologists
Physics of Sound
Propagation of Sound

The concept of strength of bond and the Theory of Bond Strength developed thereof helps to recognize the pattern of relation among the component ideas of different varieties of subjects at a deep level — at the near-seminal level. This, in turn, guides in the coextensive representation of subjects (34).

M Towards a Generalised Model of Structure of Subjects

M1 Sequence of Component Ideas in a Subject

As already mentioned in Sec J, efficiency of an information retrieval/document finding system depends, in a large measure, on the coextensive classification and helpfulness of the arrangement of the subjects forming the input to the system, to the majority of its users. Such a classification of subjects essentially involves the arrangement of the components of compound subjects in a linear sequence and representing each subject uniquely using a language of ordinal numbers. Classifying is thus equivalent to transforming the *n*-dimensional configuration of the vast ever-developing universe of compound subjects into a linear configuration. An arrangement of all the compound subjects in a sequence helpful to a majority of readers requires keeping invariant every immediate-neighbourhood-relation among all the subjects while transforming the *n*-dimensional configuration in a line. The difficult problem of invariant arises here. The number of compound subjects going with even a single Basic Subject is too large to be arranged without the aid of guiding principles. The classificationist can keep invariant one and only one of the many immediate neighbourhood-relations found in the *n*-dimensional configuration of compound subjects. Determining which component should this be and which components should come respectively as remove 2, as remove 3 etc., on the basis of conjecture of different classificationists as to what is helpful to the majority of readers would not yield a consistent pattern of arrangement of components in all compound subjects. But such a consistency in pattern is helpful and necessary to reader, classifier, and classificationist as well. In finding a solution to this problem Ranganathan's General Theory of Library Classification bypasses the phenomenal level of isolate ideas by diving deep to the near-seminal to grasp something more stable and practicable.

M2 Absolute Syntax

M21 *Postulate*

[The sequence in which the component ideas of compound subjects going with a Basic Subject usually arrange themselves in the minds of the majority of normal intellectuals may be called Absolute Syntax of ideas among intellectuals. It is conjectured that such a syntax of ideas exists. It may not coincide with the linguistic syntax — that is, the syntax of words in all languages. This postulate helps in deriving principles for sequence of component ideas in a subject. It has been suggested that a team of epistemologists, psychologists, linguists, classificationists and statisticians investigate the way in which the human mind thinks — that

is, the syntax of ideas that will give the greatest satisfaction to the largest number of readers (36). In another paper (29) we have mentioned that the work of Piaget and Inhelder in the psychology of learning, the work of Chomsky, Katz, Fodor and others in linguistics, and the statements by the educationist William H Kilpatrick and that by Bertrand Russell lend support to the Postulate of Absolute Syntax of ideas.

M3 Facet Syntax and Absolute Syntax

On the basis of the work of the scholars and specialists mentioned in the preceeding section, it can be inferred that

1 The mode of thinking/learning among normal intellectuals is substantially similar;

2 The mode of thinking/learning among normal intellectuals has remained substantially in a similar pattern for several thousands of years; and for this reason

3 The probability of a sudden change — that is, a mutation — in the mode of thinking/learning of a majority of normal intellectuals in the immediate future is quite low.

It has been suggested that the sequence of component facets in compound subjects — that is, the Facet Syntax— should parallel the Absolute Syntax of ideas. For, then, the pattern of component ideas in compound subjects is likely to be

1 Helpful to a majority of normal intellectuals;

2 Consistent in pattern in all compound subjects going with different Basic Subjects;

3 Stable and continue to be helpful to a majority of intellectuals at least in the near future — that is, until a mutation in the mode of thinking takes place;

4 Free from the aberration due to variation in linguistic syntax arising from the use of the verbal plane in naming subjects; and

5 Of help in probing deeper into the pattern of human thinking and combination of ideas.

M4 In Practice

A number of principles have been formulated and explicitly stated for securing a sequence of component facets in compound subjects going with a Basic Subject helpful to a majority of readers. These principles have been used extensively for several years now in designing schemes for classification of subjects, in classifying, and in other contexts — such as, the arrangement of ideas in the text of a book or article. One of the Principles for Helpful Sequence is the Wall-Picture Principle. It states: "If two facets A and B of a subject are such that the *concept behind* B will not be operative unless the *concept behind* A is conceded, even as a

mural picture is not possible unless the wall exists to draw upon, then the facet A should precede the facet B " (35). It has been found that the Wall-Picture Principle

1 Secures a sequence of component ideas in a subject helpful to a majority of normal specialists in the subject;

2 Is, among the Principles for Helpful Sequence, the most ubiquitous in its application; and

3 Can be deemed as the master principle for helpful sequence because the other Principles for Helpful Sequence are derivable from or are corrollaries to, it.

It may, therefore, be said that the syntax of component ideas in a subject resulting from the application of the Wall-Picture Principle parallels the Absolute Syntax of ideas. Further, the sequence of ideas resulting from the application of any of the other Principles for Helpful Sequence conforms do that derivable by the application of the Wall-Picture Principle itself.

M5 Generalised Facet Structure

On the basis of the ideas discussed in Sec K, L, M, and its subdivisions, a generalised model — the Generalised Facet Structure — has been developed to represent the overall pattern of combination of the three different kinds of ideas — namely, Basic Subject idea, Isolate idea, and Speciator idea (41).

M6 Work of CRG

The concept of Integrative Levels and its use in developing a general model for the analysis and classification of subjects being investigated by the Classification Research Group of London, is another example of the use of General Systems approach.

N Properties of Subject

In the succeeding sections we shall consider some of the attributes of system (*See* Sec H32) as applied to subjects.

N1 Symmetry and Asymmetry

A subject is an asymmetric system. Symmetry is the relation in which the interchange of the components does not involve any change in the relation. Asymmetry is the relation in which the interchange of the components involves a change in relation (16). In the linear representation of a subject (*See* Sec M1), the interchange of the position of the components can give rise to a different subject.

Example

Paint Destroys Bacteria
Bacteria Destroys Paint

N2 COMMUTATIVITY AND NON-COMMUTATIVITY

A subject is a non-commutative system. Commutation is the relation in which an addition and/or multiplication is symmetrical. Non-commutation is the relation in which addition and/or multiplication is asymmetrical (17). In the preceding section, it has been shown that a subject is an asymmetrical system.

N3 CENTRALITY

A subject is a centralised system. A centralised system is one in which one element or subsystem plays a major or dominant role in the operation of the system (18). This element is called the Leading part. A change in the leading part or its attributes may produce changes in the other components of the system. The Basic Subject component in compound subjects is a leading part. A change in the Basic Subject component can give rise to different subjects even though the non-Basic subject component may remain the same.

Example:

Medicine (BS), Child
Psychology (BS), Child
Education (BS), Child
Sociology (BS), Child

In compound subjects going with one and the same Basic Subject, the Personality Isolate is a leading part. For, the Personality Isolate determines the other special isolate facets likely to be associated with it in the given subject-context. For example, "Commodity" constitutes the schedule of Personality isolates for subjects going with the Basic Subject "Commodity Production Engineering." With different commodity as Personality isolate, different Matter Material Isolates, and Matter Property Isolates may be associated.

P Other Properties

A few other relevant microscopic properties of a system (21) are discussed in the succeeding sections.

P1 COHERENCE

A system is said to behave as a whole or coherently, if every component of the system is so related to every other component that a change in a particular component causes change in all other components and in the total system. Generally, the term 'System' is used only when some degree of coherence or wholeness exists in the system.

P11 *Example from the Universe of Subjects*

1 In a Compound Subject, having a particular Basic Subject, if the Basic Subject component is changed, the subject denoted by the totality of the component ideas in it may be different.

The example in Sec N3 illustrates this:

2 In a Compound Subject, the interchange of the position of a component idea with another in the facet structure changes the subject denoted by the combination of ideas because of the change in the relation between the components. The following examples illustrate this:

(*a*) Commodity Production Engineering, Engine—30 horse power—Motor car

(*b*) Commodity Production Engineering, Motor car—Engine —30 horse power

The structuring of the component ideas in example 2(*a*) denotes the subject " Production of 30 HP engine for use in motor car," whereas that in 2(*b*) denotes the subject " Production of motor car with a 30 HP engine."

P2 INDEPENDENCE

If the change in a part of a system depends on or effects only that part, it is called Independence or Physical Summativity. The component parts hang together in a loose manner, as it were. Such a system is also called a Degenerate System.

P21 *Example from the Universe of Subjects*

The change of a component idea in a subject, which itself is a component of a Subject Bundle may not appreciably affect the other subjects constituting the Subject Bundle. The Subject Bundle " Soil Science " may have component subjects such as Soil Physics, Soil Engineering, Soil Chemistry, Soil Biology and Soil Microbiology. A change in or addition of, an isolate idea to the subject Soil Microbiology is not likely to affect appreciably the structuring of the subjects in Soil Physics, Soil Chemistry, Soil Engineering, and Soil Biology.

A similar attribute can be thought of in relation to the component subjects forming a Complex Subject resulting from Loose Assemblage.

P3 PROGRESSIVE SEGREGATION

P31 *Kind*

1. If the changes in the components of a system lead to a gradual transformation, with time, from coherence to independence, the system is said to undergo Progressive Segregation of Kind 1.

P311 *Example from the Universe of Subjects*

The separation of a smaller chunk from a larger chunk of the universe of subjects and the latter forming an independent discipline is an example. The progressive separation of Psychology from Philosophy to form an independent discipline is illustrative of this.

P32 *Kind*

2. If the change in a system is in the direction of increasing division into sub-systems and further division of sub-system into sub-systems, or of differentiation of function the system is said to undergo Progressive Segregation of Kind 2. This property corresponds to the idea of " Growth."

P321 *Example from the Universe of Subjects*

A Main Subject may divide, by fusion, into several Basic Subjects. Each of the Basic Subjects may fission into further Basic Subjects. The subjects going with each or some of the new Basic Subjects may require differentiated schedules of isolates. The fission of the Main Subject Mathematics into several Basic Subjects — such as Arithmetic, Algebra, Analysis, Trigonometry, and Geometry — and the fission of each of the Basic Subjects into further Basic Subjects, with a differentiated schedule for some of the Basic Subjects, is illustrative of this. Such a fission process can also occur in the case of an Isolate.

P4 PROGRESSIVE SYSTEMATISATION

In this process the change is towards coherence or wholeness. It is thus opposite of Progressive Segregation. This may result from:

1 Strengthening of pre-existing relation among the components of the system; or

2 Development of relation among components previously unrelated; or

3 Gradual addition of components and relations to a system; and

4 Combination of these changes.

P41 *Example from the Universe of Subjects*

1 Two subjects going with different Basic Subjects may first be studied in mutual relation to each other. This gives rise to a Complex Subject with a Phase Relation between the subjects involved. The formation of the Complex subject is by Loose Assemblage. The relation between the subjects may gradually change to a facet relation, that is, to one of greater strength of bond. Subsequently, there may be a further strengthening of the bond such that one of the subjects may form

a subdivision of the other. The view about the development of Biochemistry until recently, was in conformity with these stages of association between the subjects Biology and Chemistry (37).

2 Intra-facet relation and intra-array relation are examples of Progressive Systematisation due to cause 2. Other kinds of "inter-disciplinary relation" can also be recognised.

3 The accommodation of new isolate ideas, speciators, and new Basic Subjects among the existing ones is an example of Progressive Systematisation due to cause 3.

P5 Concurrent Segregation and Systematisation

In one and the same system, there may be Progressive Segregation and Systematisation. This may sometimes occur even simultaneously.

P51 *Example from the Universe of Subjects*

The formation of a Fused Main Subject with schedules of its own, differentiated from those for the component Main Subjects that have fused, is an example of the process (32).

In Sec P41 we have mentioned Biochemistry as an example of Progressive Systematisation. Bio-chemistry is now deemed a Fused Main Subject — fusion of the Main Subjects Chemistry and Biology — requiring a schedule of its own more or less independent and differentiated from those for the two subjects that have fused. In this new status Biochemistry forms one of the divisions of Molecular Biology.

Another example, is the formation of a Distilled Main Subject with schedules of its own, more or less independent and differentiated from those for the subjects in which the idea forms a component isolate denoting a practice-in-action. Management Science, Laboratory Technique, and the Pure Science of Archives are examples of Distilled Main Subjects.

P6 Growth

P61 *Growth-in-Time*

Similarity in the pattern of growth has been observed in different systems. For instance, exponential and logistic patterns have been recognised in the increase of knowledge about animal species, the number of publications on specific subjects such as on Drosophila, Laser, Computer Technology, and Particle accelerators. De Solla Price has proposed different growth patterns in different areas and the relation of the pattern to social factors, research environment etc. Paul Weises has compared the growth of the universe of knowledge to that of a living organism (13, 44). A few studies on the pattern of growth of significant ideas in some

subject fields have been reported from DRTC. The similarity of growth pattern in different fields of knowledge has led Boulding and Keiter to suggest a General Theory of Growth.

P62 *Growth Rate*

Isenson has pointed out that the rate of growth of knowledge can be expressed as an equation embodying a number of limiting factors. Some helpful techniques for this come from the field of technological forecasting (23). Lenz has shown that the exponential growth curve is similar to the growth of biological population under constraint. This accounts for the S-shaped logistic growth noted in the increase of knowledge in different fields. A pattern of discovery and duplication in the field of antibiotics research has been reported from DRTC (33). Hartman pictures scientists and engineers as surrounded by an ocean of information, and considers the information as a necessary input for the creation of new ideas. He writes: "Occasionally a bit of information collides with a scientist or engineer, sometimes triggering a new idea and sometimes not. Because it is impossible to predict what piece of information will collide with which scientist and whether a particular collision will be 'elastic' or 'inelastic' the process is only statistically definable." In forecasting the trends in technological subjects, it has been suggested that a model can be derived directly from the Boltzman equation (22).

P63 *Relative Growth*

Another attribute of interest is the relative growth of component within a system. A simple relation of allometric increase has been observed in different systems and their respective components. In compound subjects going with a particular Basic Subject, it would be helpful to study. for example, the relative rate of growth between the totality of different isolate ideas in the field and that of each of the component facets, particularly the Personality facet, and the Matter facet. Study of the relative rate of growth between these components would also be helpful. For example, in the field of Medicine, the rate of growth of new ideas constituting the Personality facet (that is, human organs) is low as compared to the rate of growth of ideas constituting the Matter facet (that is, about anatomy, physiology and diseases and methods of treatment of diseases). This is so because, there is relatively little change over time in the number and kinds of human organs. As compared to this pattern, we find the number of new ideas constituting the Personality facet of subjects going with the Basic Subjects Commodity Probuction Engineering, and Commodity Production Technology increase at a fast rate. These

ideas in the Personality facet are about man-made commodities. There are subjects, such as Chemistry, in which the Personality Isolates represent ideas about natural objects and man-made objects. Thus, the rate of growth in this field may be intermediate between the two systems mentioned above. In the Personality isolates in Education and Sociology, we find rapid growth in the number and variety of speciators derived on the basis of different characteristics.

P64 *Spread of Ideas*

Goffman builds up a general theory of communication or spread of ideas by considering communication as an epidemic process (18).

P7 FREQUENCY STUDIES

In studies of the patterns of development in the universe of subjects, it would be helpful to study the frequency of incidence of the different modes of combination of ideas (*See* Sec L) at different stages in the development of subjects going with a Basic Subject. Is there a variation in the frequency of incidence of the different combinations with the different patterns of development of subjects? Similarly, it would be helpful to study the frequency of incidence of the different varieties of facets at the different stages of development of subjects going with a Basic Subject. Is there a variation in the frequency of incidence of the different varieties of facets with the different patterns of development of subjects? It would also be helpful to study the frequency and pattern of incidence of seminal and near-seminal ideas at the different stages of development of various subject-fields.

Q Recurring Pattern of Sequence of Isolates

Q1 PRINCIPLES FOR ARRANGEMENT OF ISOLATES

Eighteen principles have been formulated for the arrangement of co-ordinate isolate ideas in an array in a helpful sequence (42). Examples of such principles are: Principle of Later-in-Time. Principle of Later-in-Evolution, Principle of Spatial Contiguity, Principle of Quantative Measure, Principle of Increasing Complexity Principle of Canonical Sequence, Principle of Literary Warrant, and Principle of Alphabetical Sequence.

These principles are applicable to the arrangement of isolates in an array occurring in diverse subjects. Use of these principles help in securing a consistent pattern of arrangement of isolate ideas and also in conforming to the Canon of Relevant Sequence and Canon of Mnemonics.

Q2 SEMINAL MNEMONICS

Q21 *Property Isolates*

The Principles mentioned above are frequently and conveniently used in the arrangement of Personality Isolates. In the arrangement of Property Isolates occurring in a subject, use of a system of Seminal Mnemonics has been found helpful. In an earlier paper, the analogy between system analysis and the use of seminal mnemonics has been pointed out (28). Further work in this field, has indicated that the idea of Seminal Mnemonics should be separately applied in the arrangement of Property Isolates and of Energy Isolates. In the arrangement of Property Isolates, the following pattern in the sequence of co-ordinate isolates is found to occur in diverse subjects.

Number	Mnemonic Idea
1	Starting point (Statement of purpose, policy, problem, origin, and cognate ideas)
2	Components in an organised pattern (Input, Source, Structure, Morphology, Constitution, and cognate ideas)
3	Function (Activity, Role, Syntax, and cognate ideas)
4	Error (Disease, Damage, Pathology, Controversial issue, and cognate ideas)
5	Ecology (Environment, Contact with outside, and cognate ideas)
6	Genetics, Propagation (Future, Mechanism for development, and cognate ideas)
7	Personality (Developed stage, Holistic view, Total composition, and cognate ideas)
8	Fitness

The ideas associated with each of the numbers 1 to 3 generally denote attributes of a system as a static entity. The ideas associated with each of the numbers 4 to 8 denote attributes of the system as a dynamic entity — that, is these attributes are asso-

ciated with the survival and continuance of the system in the space-time context.

Q22 *Similarity of Pattern of Sequence*

The following chart indicates the incidence of similar pattern of arrangement of Special Property Isolates in diverse subjects. The isolate ideas are taken from the schedules of Colon Classification for the different subjects.

In column 2 the basic idea is given. It will be noticed that in the verbal plane the term used in the different subjects may be different although the idea denoted is a cognate of the basic idea (*See* Sec Q21).

Q23 *Action (Energy) Isolates*

In the arrangement of Energy isolates, the following pattern in the sequence of co-ordinate isolates is found to occur in diverse subjects.

Number	Mnemonic Idea
1	Creation, Production, Initiation, Prediction, and cognate ideas.
2	Etiology, Causation, and cognate ideas
3	Analysis, Diagnosis, and cognate ideas
4	Interlinking, Correlation, Synthesis, and cognate ideas
5	Prevention, Protection, Control, and cognate ideas
6	Treatment, Correction, and cognate ideas
7	Assembling, Integration, Decision making, and cognate ideas
8	Management, Manipulation, Implementation, Organisation, and cognate ideas

It may be noted that the set of ideas associated with each of the numerals 1 to 8 in the set of Property Isolates (*See* Sec Q21) has some correspondence to the ideas associated with the respective numerals in the set of Energy Isolates.

Q3 HELP FROM SEMINAL MNEMONICS

The use of Seminal Mnemonics — that is, recognition of the occurrence of seminally equivalent ideas but with different names in diverse subjects — aid in the accommodation of new

Number	Mnemonic Idea	Biological sciences	Linguistics	Religion	Psychology	History Political science	Sociology
1	Starting point	Nomenclature	Sound (Phoneme)	Mythology	Nervous reaction	Policy	Civilization
2	Components in an organised pattern Source	Morphology	Morphology	Scripture	Sensory stimulus	Constitution	Physical character
3	Function	Physiology	Syntax	Theology	Consciousness	Function	Activity
4	Error	Disease	Meaning	Religious practice	Cognition etc	..	Pathology
5	Ecology	Ecology	Thesaurus	Preaching	Emotion, feeling	Relation with citizen	Demography
6	Propagation	Genetics	..	Institutionalisation	Connation, movement	Source	Socialization
7	Personality	Development	Composition	Religious sect formation	Personality		Personality ..

isolate ideas in a helpful sequence and in assigning to them mnemonic notation (See table in page 469).

R Conclusion

The efficiency of document finding systems depends, in a large measure, on the capacity of the system to facet analyse in depth, structure, and arrange diverse subjects in a sequence helpful to a majority of the users of the system or the output from the system. A similar analysis and structuring of the subject of the reader's query is helpful in matching it with the facet-analysed subjects forming the input to the system, to any pre-determined degree of precision. The design and development of a document finding system capable of such analysis, synthesis and arrangement of subjects, in turn, calls for a study of the attributes of the universe of subjects, particularly its structure and development. Therefore, the study of the structure and development of the universe of subjects and of its components should form a core subject in a course on the design and development of document finding systems. The formulation of methodologies for the study of the attributes of the universe of subjects should also form an integral part of the study. Considering a subject as a system is helpful in associating and studying the various attributes of systems with respect to subjects. Further, General Systems methodology can be used with advantage in the study of the attributes of the universe of subjects and of its components.

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