CHAPTER B

METHODOLOGY

0 INTRODUCTION

The methodology used for the purpose of this study may be designated as "Logical Forms-Approach". The foundation of this approach lies in Susanne K. Langer's ideas pertaining to Symbolic Logic (48). Langer's ideas have been made into a methodology for the purpose of this study. Besides, it appears that this methodology is being consciously used for the first time in studying the theoretical foundations of SILs. For this reason, the fundamentals of logical forms-approach are furnished in the following sections.

1 LOGIC

"Orderliness and system", said Josiah Royce, "are much the same in their most general characters, whether they appear in a platonic dialogue, or in a modern textbook of botany, or in the commercial conduct of a business firm, or in the arrangement and discipline of an army, or in a legal code, or in a work of art, or even in a dance, or in the planning of a dinner. Order is order. System is system. Amidst all the variations of systems and orders,
certain general types and characteristic relations can be traced." (71). The tracing of such types and relations among abstracted forms or concepts is the business of logic.

Logic applies to everything in the world. Science and philosophy deal with interpreted patterns. What mathematics is to the natural sciences, logic, the more general study of forms, is to philosophy, a more general understanding of the world. The aim of philosophy is to see all things in the world in proportion to each other in some order -- that is, to see reality as a system, or at least any part of it as belonging to some system. Although every science may be said to deal with this topic, logic is the science of order par excellence.

In the case of philosophy especially, logic is wellnigh indispensable tool. It illuminates problems that have been obscure. It does away with innumerable notions that are merely different names for one and the same concept; it reveals inconsistencies in our more cherished thoughts; and suggests remarkable generalizations of ideas that seemed quite local in their application.

Logic is to the philosopher what the telescope is to the astronomer: an instrument of vision. A telescope does
not of itself find the object we wish to see, nor does it show us any thing at which we direct it unless we know precisely how to adjust the focus.

2 FORM AND SCIENCE

"All knowledge, all sciences and arts have their beginning in the recognition that ordinary familiar things may take on different forms" — says Susnne K. Langer. The waters of the earth through a service of process of transformation turn into clouds; and clouds into snow or rain. "Unity in diversity" is ultimately what science is all about. Science reduces diversity into mere differences of appearance. On the one hand, science seeks variants of the same staff; and on the other, unifies variants into the same staff. For instance, the vast variety of forms of the same fundamental something called "Electricity" constitute the core of its science. The diversity of appearance of the same thing may be so wide that it may be very hard to think of their oneness.

"Knowledge of things" is quite distinct from "knowledge about them". The taste of scrambled egg may be known to a child, but he may not know that it was an egg which has been scrambled. In that case, with his
knowledge of things, he will not know that boiled egg, omelette, and scrambled egg are different forms of the same thing. "Knowledge about things" consists of knowledge about their relationships with surroundings and about their structures, functions, etc.

Diversity is unified to unity through the discovery of the most general laws of transformation of the latter. The transformations of unity are the changes of its form. Science emerges through the discovery of principles of unification of variant forms of the same substance. Both "substance" and "form" belong to science; and they are of equal importance.

3 LOGICAL FORMS

The substances of science need not necessarily be material things. For example, "Philology" deals with relations among words denoting ideas. When a word undergoes changes of form, it cannot be taken to mean that it changes its shape. The meaning of "form" is stretched beyond its common connotation of shape. In this wider sense, anything may be said to have form that follows a pattern of any sort -- that is, exhibits order and internal connection. For example, we speak of

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(1) Physical, grammatical, social and musical forms;
(2) Psychological types;
(3) Norms of conduct, of beauty, of intelligence;
(4) Fashions in clothing, speech, behaviour;
(5) Designs of automobiles, motor boats, etc.;
(6) Architectural plans;
(7) Plans for a festival;
(8) Patterns;
(9) Standards;
(10) Modes; and so on.

All these expressions refer to "form" in the most general sense. In logic, "form" is used in this general sense; and it is called "Logical Form".

4 STRUCTURE

"Logical Form" is a highly generalized notion; and it covers a large number of particular ideas from geometric forms to ritual and etiquette. They must have something in common. The bridge that connects all meanings of "form" is the notion of "Structure" -- the parts and their interrelationships. The logical form of a thing is the way that thing is constructed; the way it is put together. This does not mean, of course, that it has been deliberately
put together by somebody; forms may be preconceived, or they may be natural, or accidental. For example, the powers of nature — glacier, water, and frost — have accidentally constructed the "Old Man of the Mountain". The snowflake is a detailed construct of very recognizable individual parts; but these have not been put together; they crystalize out of one homogeneous drop of water.

5 FORM AND CONTENT

The form of a musical scale is not a shape. By changing the sequence of the eight notes, different singable melodies are constructed. Order and arrangement among sounds (notes) are just as much logical form as the arrangement of parts in a physical thing. Two melodies may have every note in common; and logically we may say that the two constructs are made of exactly the same substance; and they differ only in form. If we compare these tunes, we see how very diverse may be the appearance, the character, the value of things which are merely different forms of the same given material. It is the philosopher or the scientist who finds principles by which two widely different things are reduced to the same category; and they are described as two forms of one substance.
Terms like 'thing', 'matter', 'substance', etc., normally brings the notion of "shape" in mind; and whatever has shape, we tend to call it "staff". In logic, the term 'Content' is used to denote a medium wherein a form is expressed. Logically therefore, the same content may appear in several forms. Again logically, one and the same form may be exemplified by different contents. For example, a form which is usually expressed in flesh and blood, may be articulated in lines -- such as, the picture of a human figure. Two suits of the same pattern may be cut of different cloths.

51 Russell's View on Form and Content

Bertrand Russell shows clearly the distinction between form and content in a "sentence"; and also the relation of that form to "structure" or arrangement of parts as follows:

"In every proposition and every inference, there is, besides the particular subject-matter concerned, a certain form, a way in which the constituents of the proposition or inference are put together. If I say 'Socrates is mortal', 'Jones is angry', 'The sun is hot', there is something in common in these three cases, something

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indicated by the word 'is'. What is in common is the form of the proposition, not an actual constituent. If I say a number of things about Socrates — that he was an Athenian, that he married Xantippe, that he drank the hemlock — there is a common constituent, namely Socrates, in all the propositions I enunciate, but they have diverse forms. If on the other hand, I take any one of these propositions and replace its constituents, one at a time, by other constituents, the form remains constant, but no constituent remains. Take (say) the series of propositions, 'Socrates drank the hemlock', 'Coleridge drank the hemlock', 'Coleridge drank the hemlock', 'Coleridge drank opium'. The form remains unchanged throughout this series, but all the constituents are altered. Thus form is not another constituent, but it is the way the constituents are put together ... We might understand all the separate words of a sentence without understanding the sentence: if a sentence is long and complicated, this is apt to happen. In such a case, we have knowledge of the constituents, but not of the form. We may also have knowledge of the form without having knowledge of the constituents. If I say, 'Rorarius drank the hemlock', those among you who have never heard of Rorarius (supposing there are any) will understand the form without having knowledge of all the constituents. In order to understand a sentence, it is necessary to have knowledge both
of the constituents and of the particular instance of the form ... Thus some kind of knowledge of logical forms, though with most people it is not explicit, is involved in all understanding of discourse. It is the business of philosophical logic to extract this knowledge from its concrete integuments, and to render it explicit and "pure." (72).

6 ANALOGY

We speak of "Major scale" in music and "social scale" in sociology. "Scale" means "ladder". Ordinary common sense sees a similarity of form between the order of successive tones, and that of social/sate, each being a little higher than its predecessor as the successive rungs of a ladder. That is why, any series whose separate parts are arranged so that each is either higher or lower than any other part is a "scale". The propriety of such usages is admitted by "Analogy", and analogy consists of recognition of a common form in different things.

A curve representing the fluctuations of the stock market does not look the least bit like the event. It is, indeed, a shape representing an event which has no shape in a literal sense. Its relation to the event is not that of a copy, but of analogy. All that the curve must do
is to reveal the proportion and arrangement of its parts. Such pictures are called "Logical Pictures". For, the only form which the curve and the event have in common is a logical form — that is, they have an analogous structure. It is only by analogy that one thing can represent another which does not resemble it. If two things have the same logical form, one of them may represent the other.

The syntactical structure (grammatical structure) of language is one of the most elaborate structures invented for purely representative purposes. The sequence and relationships among ideas are represented by this structure. Intimacy among ideas, and one idea leading to or originating from another are all reflected in their sequence, arrangement, connections, and pattern. Separate words denoting separate ideas are put together to express organic thoughts or propositions. The most general way of combining elementary notions is called syntax — the logical form of language; it copies the logical form of our thought.

It is analogy and analogy alone that leads us to recognize a single logical form among widely various exemplifications. The power of discovering analogies is logical intuition.
7 ABSTRACTION

The consideration of a form, which several analogous things may have in common, apart from any contents or "concrete integuments" is called "Abstraction". If we note what is common to a couple of days, a pair of gloves, and a set of twins, we are abstracting a form which each of these items exhibits — namely, its numerosity, "two". If we speak simply of a couple, without reference to any content, or simply of "two-ness" or "two", we are treating of this form in abstracto. It is easy to see that it is but a short step from the recognition of analogies, or different contents for the same form to abstraction, or the apprehension of that form regardless of any particular content.

8 CONCEPTS

The process of attending only to the form of a thing or a situation, and conveying this "abstracted" form, which we carry out unconsciously as part of our common sense, becomes increasingly important when we pass from mere common sense to scientific thinking. Such abstracted forms are our scientific "Concepts". For instance, the motions that follow the general pattern called "oscillation": the swing of a pendulum, the swaying of a skyscraper, the vibration of a violin-string
over which the bow is passing, the chatter of our teeth on a cold day. All these are examples of the type-form called "Oscillation" — a rhythmic motion to and fro. When we consider this common form of various movements, and call it by a name — such as, "Oscillation", we are consciously, deliberately abstracting the "form" from all things which have it. Scientists proceed by abstracting more and more fundamental forms; and by finding more and more things that fall under certain concepts — that is, that exhibit certain general forms.

91 INTERPRETATION

Finding things that fall under certain concepts — that is, that exhibit certain general form is called "Interpretation" of an abstract form. It is a process of looking about for kinds of things to which a certain form belongs. For example, the rolling of a wheel, the motion of a heavenly body, and the spinning of a top are kinds of things to which the abstract of "Rotation" belongs. The process of recognizing all different contents for the abstract concept "Rotation" is the interpretation of the logical form denoted by the term 'Rotation'. Two exactly similar spinning tops are regarded as two instances of one content for the same form. The special sciences take cognizance of all those and only those conceptual patterns or formulae, to
which they can give some interpretation relevant to their chosen matter. Interpretation is the reverse of abstraction; the process of abstraction begins with a real thing and derives from it the bare form, or concept; whereas the process of interpretation begins with an empty concept and seeks some real thing which embodies it. In the sciences, as in ordinary life we are interested in forms only in so far as they are patterns of certain things that concern us. There are, essentially, two ways in which new forms of things are discovered:

(1) By abstraction from instances; and

(2) By interpretation of empty forms we have quite abstractly constructed.

A "MODEL" is an instance of interpreted special form.

92 ESSENTIALS OF LOGICAL STRUCTURE

Some of the essentials of logical structure, in the context of its fundamentals presented in earlier sections, may be enumerated as follows:

(1) Logical form of a thing depends upon its structure -- that is, upon the way its several parts are related to each other.
(2) Ideal parts are geometrically distinguishable, through they may be set off from each other by artificial or even purely imaginary devices.

(3) The related parts of a logical structure may be physically separate; or first existing alone and then brought into combination; or they may be physically inseparable qualities, aspects, location, etc. For this reason, "parts", in the context of logical structure, are referred to as "elements", or "factors".

(4) The elements in a logical structure must be conceptually distinguishable.

(5) Elements alone do not constitute a structure; there must be relations that hold among them.

(6) Without adding or subtracting any of the elements in the composition of a thing, it may be possible to change the character of that thing by changing the relations of the various elements to each other.

(7) Two things of very diverse material may have the same logical form. This is because many different things may enter into the same relations.

(8) The elements which are connected by a relation are called terms. Every relation must have terms in order to become visible to the understanding.
The most elementary characteristic of any relation is the number of terms it requires. If it connects two elements at a time it is said to be "dyadic", if three "triadic", if it has four terms "tetradic", and so forth. This numerosity is called the "degree" of the relation. Some relations have no definite degree, but are merely more than "dyadic", and they are called "polyadic".

The commonest means of expressing a relation among several terms is the "proposition".

The range of general subject-matter of terms and relations that may enter together into thoughts is called a "context". Everything that can enter into a scientific discussion must be constructed within the conceptual frame, which may be called "formal context of discourse". The formal context of any discourse may be agreed upon and expressed; the psychological context cannot.

"Concept" is the abstracted, public essential logical form; while "conception" is the private, personal mental image of a concept.

The total collection of all those and only those elements which belong to a formal context is called a "universe of discourse". In logic and science, the universe of discourse must be definite enough to allow no dispute whatever about what does or does not belong to it.
In general terms, the Logical Forms-Approach consists operationally of the following steps:

(1) Analysis of the products of a system to recognize specific terms and specific relations among them.

(2) Application of generalization to classify specific terms and specific relations into a few categories of elements and relations.

(3) Application of abstraction to determine the logical form of the system products.

(4) Application of steps (1), (2), and (3) to a second system, third system and so on, considering one at a time.

(5) Examination of two or more logical forms to determine if they can be regarded as derived models of some more abstract logical form formulated by applying "abstraction" of a higher level.

(6) Continuation of the process of "abstraction" till the derived models are found to be conceptually removed from the abstracted logical form.

(7) Application of "interpretation" to each system product after every step of "abstraction" to
confirm the validity of the abstracted logical form; to revise the results of earlier analysis, generalization, and abstraction wherever warranted; or to discover new, interpreted special logical forms (models).

94 APPLICATION—POTENTIAL OF LOGICAL FORMS—APPROACH

Susanne K. Langer has given an excellent account of the application-potential of logical forms—approach relating to natural languages. The passages are quoted here chiefly because it shows indirectly its application-potential relating to SILs, which are essentially artificial languages largely based on specific terms and specific relation indicators of natural languages:

"Informing a conceptual picture of a construct, as we do when we 'describe' it in language, we must have items in the language-picture to stand for the elements, and also items of language to represent the relations. There are so many ways of relating elements that relations must have names. In fact, one might say that the conveyance of relationships among elements is the real function of language. If our interest centred entirely upon things, we would not need the whole system of nouns and adjectives, verbs and prepositions which we call a
grants and demonstrative gestures would serve almost all purposes of communications. But relations are not things we can point to; they cannot be known by pure acquaintance; a knowledge of how the elements of a thing belong together is always a knowledge about this thing, and requires a logical picture such as a grammatical word-picture, for its expression. We must have signs for elements and signs for their relationships. And that is just what we have in language. Such words as 'upon', 'to the right of', 'near', 'greater than' are names of relations. They do not denote elements in a construct, but the way these elements are arranged. The same is true of such words as 'loves', 'hates', 'knows', 'writes to', 'escapes from', they are expressive of relationships into which certain elements may enter with each other."

"Any symbolic structure, such as a sentence, expresses a proposition, if some symbol in it is understood to represent a relation, and the whole construct is understood to assert that the elements (denoted by the other symbols) are thus related. In ordinary language, the verb usually performs both functions; it names the relation and asserts that it holds among the elements. But if, as is often the case, the relation is named by
a preposition or other kind of word, then an extra verb is required to assert the relation. This is the 'Auxiliary' use of the verb. For example, in 'Brutus killed Caeser' the verb furnishes both the name of the relation and the assertion that it holds; but in 'the book upon the table', the preposition 'upon' merely names relation, without making any assertion; to make the structure a proposition, we need an auxiliary word, e.g. the verb 'is', to assert that the relation holds between the 'book' and 'the table'. 'The book is upon the table' is a proposition. The relation is named, and is said to hold between the elements."

"In a logically perfect language, nouns represent elements, and verbs relations. In symbolism, no distinction is made between verbs, prepositions, adjectives, and relation denoting nouns."

In order to appreciate the application-potential of the logical forms-approach relating to SILs, let us consider the following propositions in English language:

(1) The subject of document 1 is field crops.
(2) The subject of document 2 is cereal grains.
This sort of propositions in a natural language may be considered to form the de jure basis of any SIL. The first step in transforming such propositions into a SIL is to consider the portion of propositions consisting of "The subject of document ... is" as universally implied in any proposition in a SIL. And therefore, no attempt is made to represent such portions of natural language propositions in SIL propositions. Because of considering them as implied the assertion value of SIL propositions is deemed to remain intact. As a result, the de facto basis for SIL propositions becomes the portions such as the following:

(1) Field Crops.
(2) Cereal grains.
(3) Wheat
(4) Irrigation farming of wheat.

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Portions of natural language propositions — such as, 'Field crops', 'Cereal grains', 'Wheat', and 'Corn' are universally recognized as terms of SIL propositions. At the same time, each term of this type by itself is a SIL proposition; for, it is assumed to have its assertion-value. At the very first step of deviating from the concerned natural language, this new feature crops up in the concerned SIL. In a SIL, therefore, any representative of an element whether or not connected by a relation, is a "term".

The following may, in general, be considered as some of the essentials of an ideal SIL:

(1) Extensive provision of users' terms-of-approach;

(2) Adequacy of term-combinations to facilitate matching of users' specific requirements;
Ease in understanding the message conveyed by a term or a term-combination;
Ease in recognizing systematic groups of subjects; and
Ease in recognizing associative groups of subjects.

The requirement of incorporating the quality of "ease in understanding, the message" calls for adequate emphasis on "universe of discourse" and "formal context". The requirement of incorporating the quality of "ease in recognizing systematic and associative groups of subjects", calls for several artificial devices — such as, omissions of names of relations as far as practicable, ignoring them fully or partially in arrangement, representing relations by some other devices, and introduction of notation to represent terms and/or relations. In spite of all these artificial measures, in a SIL proposition the logical form remains, the quality of assertion remains, the capability of conveying message remains. In case of notational representation only, the contents change. As a result, in a SIL, as in any natural language, we can recognize "universe of discourse", "formal context", "propositions", "assertion-values", "messages", "terms", "elements", and "relations". Therefore, SILs are fully amenable to
study by applying logical forms-approach. This conclusion becomes more convincingly acceptable through the study of the structural linguistic theory (25).

95 GENERAL OBSERVATIONS ON THE METHODOLOGY

In general terms, logical forms-approach consists of the application of philosophical logic to the study or investigation of any existent. It aims at

(1) Finding many logical forms for a given content; or

(2) Abstracting a common logical form from diverse structures and/or contents to formulate concepts; or

(3) Interpreting known concepts.

Essentially, "abstraction" and "interpretation" are the two ways by which new patterns or structures are discovered. A specific "model" emerges out of "interpretation"; and each specific "model" is an instance of interpreted logical form.

Logical forms-approach

(1) Throws light on obscure problems;

(2) Unifies notions;

(3) Ensures systematization;
(4) Reveals inconsistencies in thought; and
(5) Suggests generalization of ideas seemed to be specific in their application.

The general theory of SIL presented here is the outcome of studies made of the following SILs:

(1) Some of the major subject indexing languages developed up to the middle of the nineteenth century (21);
(2) Cutter's language of Specific Subject Indexing (8);
(3) Dewey's language of Decimal Classification complemented by his language of Relative Indexing (9);
(4) Kaiser's language of systematic Indexing (16); and
(5) Ranganathan's language of Colon Classification complemented by his language of Chain Indexing (7).

The primary focus of this study has been the regularity in the structures of the SILs mentioned above. Search for regularity has shown that every SIL considered for this study is not uniformly regular throughout its scheme, or its regularity is not readily ascertainable in each and every procedural step. For example, Cutter's language and Dewey's language cannot be claimed to be uniformly regular in their structures. But they display
regularity to a considerable extent. Criticism of individual SILs is not the purpose of this study. Therefore, the negative points have been deliberately ignored. Only the positive points in regard to the regularity in structure have been the basis of this study.

Each of the SILs considered for this study has been theoretically studied in terms of its elements and relations among the elements. By applying "logical abstraction" these elements and relations wherever warranted, have been categorized. The categories of elements and their relations have been further generalized to generate a tentative logical form to comprehend the structures of all the SILs considered. The structure of each SIL has then been studied by applying "logical interpretation". More insight about the structure of each individual SIL has been gained by this process. The tentative logical form has been refined in the light of the results gained by this process.

Obviously, it has been a two-way study: from particulars to abstraction, and then from abstraction to interpretation leading to further refinement of the abstracted logical form.
For the purpose of presentation of results, the general theory of structural linguistics of SIL centring round the abstracted logical form has been put first. It has been followed by its interpretations centring round each of the outstanding SILs considered.