The Semiotic Web —
How to Frame World Wide Knowledge.
Concept Technology for the Scientific World View

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Abstract. In this paper we discuss and define semiotics as a systems science and propose it along with two formally defined frameworks of metalanguages for natural-like but semiformal description of concepts and knowledge, called 'Diagraphica' and 'Symbolica. Together Diagraphica and Symbolica are supposed to constitute the foundation for a concept technology and a tool for universal concept engineering and construction of well structured conceptual and world models capable of structuring, organization, construction and management worldwide knowledge.

Our aim is to develop conceptual tools and gradually construct and refine, according to the best principles of the systems paradigm of the methodology of science and technology, that is, systems and computer-aided analysis, planning and design, of a universal framework for the construction of the scientific world view comprising of all sciences, that is, of Unified Science.

The notion and programme of Unified Science was originally formulated in by the Vienna Circle philosophers and scientists, notably by the Germ. physicist and philosopher of science Rudolf Carnap (1891-1970) in his philosophy of unified science, essentially formulated in his books "Der Raum, ein beitrag zur Wissenschaftslehre" (1922), "Der logische Aufbau der Welt" (1928) and "Logische Syntax der Sprache" (1936), and Introduction to Semantics" (1942) in which he described his constitution theory, unified language and of unified science programme.

In this paper, prior to the discussion of our approach to a Unified Science a review is made of the history of the Vienna Circle programme and their philosophy and methodology of science and the principles according to which the program should be accomplished as well as of the background and fate of the grandious dream, including the political, religious and military circumstances and developments obtaining in Germany and Austria in the Prewar Period which brought the programme collapse.

As to the title of this paper, it is appropriate to note and to emphasize that it was not only due to the breakout of the war that caused the programme to fail. In the Postwar period it became clear that the programme would have collapsed anyway if pursued along the strictly physicalist and logicist methodology known also as 'logical empirism', a term originally coined by the Finnish philosopher of Eino Kaila (1890-1958) in 1926, was found incapable of explanation of phenomena of qualitative emergence, that is, systems effects.

The methodological shortcomings became evident along with the invention of the universal digital computer and the development of the systems, information and computation theories and sciences in the Postwar Period. Additional meth-

odological inadequacies included the missing of any true theory of syntax, let alone of semantics which continues to be missing even today and is not, in the light of semiotics, ever expected to be possible of development in its current paradigm.
In this paper we present an outline of the design principles and concept technology of the Diagraphica and Symbolica universal systems description frameworks and languages for the definition of Unified Science as the super-framework for the structuring and organization of scientific world model and of worldwide knowledge in general, that is, whether scientific or of whatever category.

1 Introduction

We do not discuss in this paper any specific systems theories and sciences for the sheer rear reason of their variety, extent and complexity as fields and traditions although they were conceived as independent methodological science only half a century ago. All we can do in this context is to characterize them and to emphasize their qualitative differences as compared with both classical and modern special sciences, with the exception of mathematics and logic which as alone can be considered as universal methodological sciences before the conception of the systems, information and computation sciences.

The term 'system' and systems concepts and systems thinking have been used by man from the times unknown in everyday life, religions, philosophy, sciences and specially in engineering. Aristotle discussed the concept of a system in natural philosophy, Galilei introduced the term to science as 'systema cosmicum' (1632) and the Austr. theoretical biologist Ludwig von Bertalanffy founded systems theory as a field of its own (1948).

After the 2nd World War a wealth of systems theories and sciences began to prolify and continue to developed in an explosive manner. The systems sciences have not, however, been unified yet because they are very complex and are not yet fully understood, especially their relations are still in many respects unclear.

The author has been involved in systems sciences and systems engineering since the early 1960s and been intrigued from the very beginning with the interrelations of the classical and the ever new special theories and fields of systems sciences which continue to emerge and in bringing them into some rational overall conceptual framework. This is the subject also of this paper, unification of the classical and modern systems sciences and with the systems sciences al sciences.

This goal is not at all unrealistic since systems sciences are the sciences which deal with complexit and the world and the complexity of the world are finite ad most of the natural sciences have already solved the basic but simple problems about nature and cosmos. IT only remains to solve the complex problems which remain in life, human and cultural sciences most of which are after all also simple with the exception of the fundamental problems of life and mind which are the keys to the solution of all other problems.

In this paper we approach these questions and goals from the point of view of developing a unified semiformal and seminatural language for conceptual analysis and description of complex natural systems irrespective of the phenomenal sphere. The language should allow to clearly define scientific concepts and to describe the overall constitution of the world according to the scientific worldview offered today by the classical and modern special sciences and the methodologically interdisciplinary systems sciences.

The Symbolica language is designed so as to allow to unify the descriptions required by the classical and modern mathematical and the special natural, life, human and cultural sciences together with the systems sciences. Such a description language should allow constructing the scientific worldview in a correctly organized form and in a disciplined manner.

The notations of the metalanguage necessary for the definition and description of the systems theories are minimal since they already belong to the subject matter rather than metalanguage design. The same is true with respect to any field of application from elementary particle physics to cosmology and from atoms to molecules, man and beyond, mind, languages, societies and cultures and natural and cultural history of the human civilization.

The Symbolica language allows describing any kind of entities in the known universe in terms of a semiformal natural language in a structured and disciplined way as declarative and functional definitions as in computer programming.

In fact, when implemented on computer, the Symbolica language becomes unified language of science which is equally readable to men and machines. Until its implementation it is only a language for the facilitation of human analysis, understanding, explanation and design of complex systems. It is most useful also for teaching and education of complex phenomena, theories and to disseminate the scientific world view and conception of man.

The fairly limited set of basic mathematical theories supplemented and unified with the essential theories of systems and computer sciences allow to define unordered and ordered sets of entities, composite entities, bubbles, relations and systems of entities involving causal relations — simple, branching, joining, linear, acyclic, cyclic, hierarchic, recursive and indefinitely complex forms of causality and self-causality — to be defined and describe using freely natural language words and problem-close scientific terms and notions to any level of organization and complexity in a conceptually natural and elegant way.

An important design principle of the language, and not only its design but also its use, should be the principle of natural-like formal language, that is, the use of natural or natural-based words and terms as names as identifiers of entities, properties, relations, functions etc. constructs and systems all on all levels, which, however, are completely free for the language user to choose or coin for any purposes which may arise provided that they are well-defined within the Diagraphica and Symbolica description language grammars.

Of course, a relatively loose semiformal natural-like use of words and terms, including user defined words and terms, does not guarantee any rigor of the meanings of the descriptions because the meanings are born in the minds of the programmer and the reader, in their language and world views and models which are more or less idiosyncratic for every single person, not to mention machines.

There is, however, no other possibility to start constructing world wide models of scientific world view. Even scientists disagree, misunderstand or do not understand at all their definitions, even in mathematics and logic. A natural-like language use within a well defined formal framework has at least the advantage that it imposes certain overall discipline and unification to descriptions without posing overt formal restrictions to expression and description of conceptual knowledge and thought.

2 Semiotics as a Systems Science

Of on the level of mental systems in a hierarchy comprising a dozen or so lower and higher level systems and introduce a unified systems description language based on discrete mathematics, logic, algebra and computation theories and natural language terms and scientific and technological terminology.

The name of the language is Symbolica and it has also a graphical form called Diagrammatica which is logically equivalent with the symbolic form and allows formulas to be translated from one form to the other. In this paper we outline and discuss only the symbolic form since it is adequate for the purposes of conceptual yet precise discussion.

We define a system conceptually as a any entity which may be elementary or composed. An elementary system consists of a single element. A single element is distinguished from other elements by its unique identity which is considered as given in terms of substance, space and time. Moreover, elements are assumed as immutable and eternal, they cannot be created nor destroyed and they are finite in number.

We may call elements also atoms and characterize as atomic in the sense that they are indivisible and cannot be broken down to more elementary parts and nothing can be said of their internal content, structure or function. In a sense, an element is an epistemic and relative concept, since even elements may be constituted from some smaller things of which have, however, no possibility to know anything as was the case formerly with natural atoms an is still with some of the so called elementary particles in physics, not to mention quarks and gluons.

Elements are, however, of similar and of different kind and their kind is characterized and defined by a set P of properties pi

$$P = \{p1, p2, ..., pk\}$$

The set of properties of any one and the same kind of elements, say Q, is different by at least one property from any other kind, say R, in order to be different and distinguishable from other kinds of elements.

Elements of the same kind are said to constitute a class of the respective kind. We say also that the set of properties of a given kind defines the quality of the elements belonging to a class. Thus, all elements of a class are equal or similar with respect to their quality but not with respect to their identity. This is to say that elements of one class cannot be distinguished from other members of their own class by their quality but only by their individual identity of substantial uniqueness in space and time.

We may denote entities of different kinds by lower case letters, say a, b, c, ... and their kinds and classes by the same upper case letter, say A, B, C, ..., respectively. Sets or classes of individual elements of one kind are distinguished by indices which indicating identity uniquely, say {a1, a2, a3, ...}, {b1, b2, b3, ...} etc. For simplicity, we may also use the convention of denoting entities of the same kind as {a, b, c, ..} whenever there is no danger of confusion of meaning.

We can now proceed to construct more complex entities and systems of entities. A composed entity is an entity which may consist of two or more elements of the same or different kinds. Composed entities are called also composite entities or simply compounds. Examples of compounds in physics are atoms, which are compounds of elementary particles, and in chemistry molecules which are compounds of atoms.

Since compounds are entities they, too, have their unique identity and individuality with respect to their substantial composition and existence in space and time. Unlike elementary entities, however, compounds are not permanent or eternal since they can be formed and taken apart again.

When a compound is formed it is said to emerge, come into being or be born and when they are taken apart they are said to disappear, cease to exist or to die away. Note, however, that nothing can be created from nothing and nothing can be destroyed into nothing. But still, something new can emerge as if from nothing and can disappear as if without leaving any trace of itself.

In either case the elements out of which the compound was created do not come or go away since they are immutable and eternal. Therefore we must be careful about what is meant by coming into being, what precisely is new and what is old, and whaat is meant by going away, what precisely disappears and what does not. What are really the things or qualities which come and go and what not. This is not at all a trivial question to answer if we really want to be precise and understand the crux.

A precise answer to this question is also an answer to the questions of 'What is identity?, 'Who am I?', 'Where do we come from?', 'Where do we go after death?', 'What is individuality?', 'What is soul?', 'Does the soul survive death?' etc. related questions which have been doomed as unsolvable and of which wishful beliefs abound in religions, philosophies and even in science even though already Aristotle had the answer. More definitely, the answer has stated in terms of technology and systems sciences in the 20th century as we will see later. At this point we will only outline the founding notions and notations.

Substantially, nothing comes into being and nothing goes away. With respect to quality, however, something really does emerge and disappear since an entity of a new identity and of a kind and class of compounds is formed. We shall denote a compound entity by enclosing its constituents into parentheses, say (a,b).

A compound is an entity of different kind than either one of its components. We say that the compound is a whole composed of parts and constitutes a composite system with unique identity and quality of a new kind and class of entities which did not existed anywhere at all before their emergence nor after their decay.

Other compounds of the same kind and class can be formed out of the same kinds of elements in similar compositions. The individuality of compound systems is defined by their boundary, the brackets, which demarcate or delimit the system and divide the world into to parts, the inside and the outside of the system. The outside of the system called also its environment. Unlike elementary systems, compound systems have not only individual identity but also internal contents which may consist of its composition in terms of the kind of elements out of which it is constituted and possibly their order, relational structure and functionality.

Compound of two elements are called pairs. If no difference is made between two pairs (a,b) and (b,a) we say that a the pair is nonordered or undirected. Otherwise it is ordered or directed. More general nonordered and ordered compounds may consist of three or more elements and are called respectively sets if nonordered and sequences if ordered or directed. Sets consisting of n elements are called n-sets and sequences of n elements respectively n-tuples. Ordered sequences are called also strings, words or sentences.

Sets have no structure while pairs and sequences have a simple linear structure. In terms of structure unordered pairs are called

- lines or edges, denoted as (a — b) or (<—> b), and ordered pairs
- arrows or arcs, denoted as (a —> b) or (b <—a).

Analogously, unordered linear sequences are called chains and ordered linear sequences respectively paths.

The above terms come from graph theory. Graph theory is a generalization of set theory in the sense that it does not deal with sets of elements but also sets of pairs of elements of that set, that is, sets and binary relations defined over the elements of the set.

General graphs, denoted by a pair of sets G = {N,E}, constitute a special class of discrete mathematical structures which are more complex next to simple sets. Both simple sets and graphs are the two simplest classes of relational stuctures. By structures one usually understands graph-like structures such as nets, networks, grids etc. which consist of points or nodes and joints, connections etc. connecting them. Without respect to the size or density, that is, complexity of graphs they are topologically simple relations because they involve and consist of at most points and pairs of points.

Relational structures of higher order, instead, are defined as composed of sets of n-tuples of any degree n from 1 to n, that is, R = {N1, N2,..., Nk}, where Ni are sets of n-tuples of order n, called n-complexes, become overwhelmingly complex already in the order of = 3. Examples of R3 are structures manifested by foam and cellular structures of animal and plant tissue.

Even the simplest kind of general relational structures, which consist of only a single set of n-tuples, that is, n = k, where k is a constant, and are made of k-dimensional entities in the series point = 1-tuple, pair = 2-tuple, triangle = 3-tuple, tetrahedron = 4-tuple, ..., k-simplex = k-tuple, called simplicial k-complexes, are incomprehensible already in four dimensions.

The general k-dimensional relational structures called complicial k-complexes and consisting of any order of i-tuples, i ≤ k, are as complex as discrete complexes of order k can ever be.

We do not need to consider general relational structures nor discrete complexity any further here. There are still other forms of complexity in mathematics, logic and the theory of computation and computability which are studied in the general science of complexity. It suffices here well to get some idea of graphs, graph theory and the kinds, classification and potential complexity of graphs.

The world of graphs, that is, of 2-complexes, allows us enough complexity to discuss the fundamentals and principles of most phenomena, problems and question in nature, life and mind as well as culture, if not all, however. The reason for this is the fact that in 3-dimensional space potentially graphs of infinite number of nodes and infinite density of connections can be embedded, that is represented and realized. This possibility has well been taken advantage by the nature itself as manifested by the emergence and evolution life, mind, thought and language.

For instance, the most complex graph or network known to science is the neural network of the human brain. It consists of some 100 billion, in European terms, of neurons each of which may potentially have 10 000 connections to other neurons. In 3-dimensions there is, however, no upper limit to the number of nodes nor to the the number of connections between any to nodes. This is property of the topology of 3-dimensional space. There are, however, definite limits to the complexity of 3-complexes in 3-dimension.

To have some idea or at least an intuition about graphs is necessary for several reasons as a prerequisite for understanding (1) the fundamental principles underlying simple and complex forms of causality which underlie the complexity and diversity of the real real world and the possibility, origin and evolution of self-complexification and self-diversification phenomena and processes in the nature.

For the second, (2) graph theory, especially of cyclic graphs, is necessary for understanding the difference between noncyclic and cyclic forms of causality, that is, between causality and self-causality which is necessary to understand the difference between the nonliving and living nature and the possibility of the emergence and evolution of life and the self-complexification and self-diversification of life forms and as well as the respective phenomena and processes on the mental, linguistic and semiotic levels of human and natural systems.

For the third, (3) since we are dealing with complex problems we need also appropriate methodological concepts, theories, representation languages, means and methods for defining and representing precisely enough, even though conceptually, the necessary problem-oriented notions and models of the object phenomena, processes and systems under study.

Of course, we cannot do much in one paper, but we can show the relevance of the methodology to the problems and the way how to proceed. For this purpose we continue still a bit our introduction of the methodological concepts and theories.

Graphs are defined in terms of a set N of elements

$$N = \{a, b, c, ..., n\}$$

and a set of E of pairs of elements denoted as

$$E = \{(x1,y1), (x2,y2), ...(xm,ym)\} \text{ ; xi, yi members of N}$$

composed of elements of the set N. Hence, graphs are entities of the kind G = [N,E]. Graphs are called undirected if the pairs are unordered, denoted as (a — a) or (a <—> b), and directed if they are ordered and denoted as (a —> b).

Analogously, directed graphs are often denoted as G = (N,A) where A reminds of arrow pointing from a to be as contrasted with E for edge or undirected line connecting a and (a —> b) either unordered or which we denote as a pair of the respective kinds and are denoted by are an example of more general ore complex structures are called

We denote compound types by enclosing the kinds of the constituting parts in brackets, in this case [A,B]. We may also give a name to the kind and class by introducing the notation Class: [X,Y, ...], in this for instace Pair: [A,B]. We can say also that a class is of type [X,Y,, ...], of type Class, or as in this case of type Pair.

Introduced some formal or semiformal symbolic notation based on simple and self-evident conventions and natural language semantics it becomes possible to concisely and conspicuously define more complex types of systems and notions which would verbally become too complex to understand even intuitively. This is necessary because systems sciences are about complexity. They have been conceived and developed to allow analysis, description and synthesis of complex phenomena, processes and systems such like engineering, biological or mental systems, natural or artificial.

3 Definition and Description of Entities and Systems

We have so far considered entities and systems as abstract mathematical objects with little attention on how to define and represent specific types of entities constituting different kinds and classes. In this section we consider the following questions and aspects of complexity from the following points of view:

- Graph Complexity and Diversity
- Graph Typology and Grammars
- Graph Notations and Languages
- Symbolica — a Unified Description Language

For the definition of a description language we need some language which is normally called a definition language or metalanguage in terms of which the grammar, syntax, semantics and pragmatics of the description language can be defined.

In ordinary speech and writing we describe things in terms of some natural language whereas in science consciously designed and precisely defined formal languages are used. Examples of forma languages are the languages of mathematics, logic, particle physics and chemistry, to mention a few.

Formal languages need be defined and the definition language normally is some natural language in terms of which the basic notions, constructs, operations and their meanings are defined in a way dictionary definitions of word meanings are formulated in word articles.

Typically, in addition to using natural language word, special symbols are often introduced and defined to have certain well defined syntactic, semantic or pragmatic function and meaning. Examples of special symbols are separators, delimiters, operators etc. which are used define the notational and interpretational conventions.

Often, however, direct definition of a formal language is not adequate or desirable for one reason or another. This is the case for instance when more than one language of the same or similar type need to be defined or discussed or referred to from outside. Then either a metalanguage of a language capable of self-reference is necessary.

Natural languages have this remarkable property of being able to refer to entities and constructs of themselves. Examples of self-referential means, devices, mechanisms and notations are, for instance:

- quotation — 'quotation', "quotation", 'this is a quotation' etc.,
- metanotions — word, vocabulary, grammatical categories etc.,

- self-referential words — this, I, me, reflexive and deictic words and devices.

In natural languages and communication the principle of self-reference an everyday feature of discussion. In mathematics and logic self-reference is also a common and important device but often also problematic since it may involve infinite regress or self-contradiction, that is, paradoxes, deadlocks, indefinity etc. situations where they are undesirable. Often they are also useful.

In the theory of computation and in real computations self-reference does not cause such problems as it does in mathematical and logical idealizations since computations are natural phenomena which involve space, energy, matter, time and causality, which solve the problems of infinity, contradiction etc. Examples of self-reference in mathematics, logic and computation are repetition, iteration, recursion, self-recursion etc.

After all, all theories of mathematics, logic and computation themselves involve and are based on the principle of self-reference and causal self-construction. The same applies to natural language, human thought, consciousness etc. and their evolution, are all based ultimately on the pinciple of self-causation.

Therefore, if we wish to design a language for description of natural entities and systems of any order of complexity and diversity, it is of utmost importance that the description language has the necessary facilities for self-reference.

As to metalanguages, they are of two principal types, external and internal, that is, (1) the metalanguage is a separate language from the language it is used to define or to discuss, the so called object language, and (2) the metalanguage is part of the object language which is made possible by some mechanism of self-reference.

All formal languages, be they object languages or metalanguages of any order, are, however, ultimately based on some natural language and all natural languages on the language of natural thought, which again is based on natural neurology, biology, chemistry and physics, albeit not in any simple but rather in complex systemic ways all based on natural self-causation.

The adescription and definition languages are ultimately based on some natural language although formal languages such as the languages of mathematics and logic description of Symbolica we need a rich enough to allow not only definitions of symbols, alphabets and grammars for defining languages but also self-der.

We will now outline a plan for a universal formal or rather still semiformal symbolic and diagrammatic language for description of entities and systems of any type and order of complexity in conceptual terms. The use and design of such languages derive their origines from mathematics, logic and engineering sciences, notably systems analysis, design and engineering with a cultural history of millenia from the first man made pictures to automatic programming systems.

4 Unified Description Languages

The first dreams of universal formal languages in philosophy, mathematics and logic were put forth in the New Time by the Brit. philosopher John Wilkins (1614-1672) in proposing a philosophical sign language as discussed in his "Common Writing" (1647) and "Essays towards a Real Character and a Philosophical Language" (1668).

In philosophy the Germ. mathematician and philosopher Gottfried Leibniz (1646-1716) formulated his doctrine of universal souls, spiritual entities, based on the Pythagorean idea of numbers as souls and the notion of monad, Gr. monas, one, unity, "La monadologie" (1714).

Leibniz pursued the ideal of unification also in sciences and dreamed of universal languages of mathematics, logics and computation known as analisis diffeentialis, lingua universalis and machina ratiocinatrix capable of descrption, inference and computation by machine of all phenomena, theories and knowledge.

The differential and integral calculus became a breakthrough and immense success as the foundation of classical natural sciences in the following centuries. The latter two ideals remained, however, only dreams but were revived in Modern Time.

In the 1930's the the first multidisciplinary community of philosophers and scientists known as the Vienna Circle took up Leibniz's program of logic now based on mathematical logic as founded by the Germ. logician Gottlob Frege (1848-1925) in his "Begriffschrift" (1879) and developed by the Brit. logicians Alfred Whitehead (1861-1947) in his "Universal Algebra" (1898) and Bertrand Russell (1872-1970) with the development of logicism and universal type theory.

Based on logiscism the Vienna circle scientists, notably Rudolf Carnap (1891-1970), developed a unified theory of the constitution of the world and a unified language of unified science for the description and derivation of unified science in his two books "Der logische Aufbau der Welt" (1928) and "Logische Syntax der Sprache" (1934).

The logicist program of a unified language and a unified science based on it remained, however, still a dream since the underlying assumptions of the possibility and adequacy of mathematics, logic and logical constitution of the world from physical concepts alone turned out to fall methodologically short of the goals.

During the 2nd World War, however, the universal digital computer was invented followed by the conception and explosive development system, information and computation sciences, especially of formal language and programming sciences, made possible the development of a variety of formal description, programming and other languages including symbolic and diagrammatic language for the analysis and design of complex systems.

Examples of such languages are programming and data description language, languages for symbolic and structural computation and programming, languages for computational linguists and artificial intelligence, languages for knowledge representation and concept definition etc. many which are universal in principle but suffer from various defects as to their scope of applicability, convenience etc.

In the computer age the US mathematician and computer scientist John McCarthy (b.1927) at MIT coined the term 'artificial intelligence' and saw early (1956) that there is a need for a symbolic programming language which would be capable of computing with symbols and symbolic expressions like mathematical and logical formulas or with natural language words, sentences, concepts and thoughts.

McCarthy proposed his ideas to be incorporated in Fortran, the first automatic programming language being developed (1957) at IBM by a task group for which McCarthy acted as a scientific advisor. The other members of the group did not, however, accept McCarthy's ideas because they were locked up in the idea of automating the programming of numerical algorithms and calculations only.

So, McCarthy went his own way and designed and implemented Lisp (McCarthy 1960) which became an immense breakthrough and success in theoretical computer science, programming technology and application of computers and automation especially to computing in a variety of spheres of symbol manipulation on the level of formal and human languages, symbolic mathematics and logic, intelligence, thought and knowledge.

In the 1980's the next step was taken by the Brit.-US mathematician and computer scientist Stephen Wolfram (b.1999) in developing based on the ideology of Lisp the 'Mathematica' (1986) system allowing to program in a truly clean and elegant form the entire field of mathematics much of which has already been done during only about two decennia.

Until today no truly elegant and convenient universal language for general knowledge representation and definition, description, programming and computation with concepts has yet emerged although artificial intelligence and knowledge representation in many fields of application have been pursued for nearly half a century.

We can, however, already foresee that this will happen within the foreseeable future and signal the beginning of a new age in not only computer science byt in the human and computer civilization since it will allow for programming of the scientific world view, and for that matter, whatever world view, to the computer and allow the computer to autonomously learn to understand, in the true sense of the word, human languages and literary culture.

The only obstacles for this are the complexities of the phenomena of the human mind, thought and language and missing of a universal and convenient language for definition and description of human languages, concepts, thought and mind, and of entire world views, including self-conceptions of men and machines.

5 Principles of 'Symbolica' and 'Diagrammatica'

One of such effort is being pursued by the author under the marks 'Symbolica' and 'Diagrammatica' or 'Diagraphica' (Seppänen 2002), a symbolic and diagrammatic language, which together one language which has two equivalent but different forms of representation, symbolic and graphic, and can be automatically translated between the two forms.

The symbolic formalism is based on the programming language Lisp (McCarthy 1960) and graph theory which the author has worked with and applied to computational linguistics and artificial intelligence since the late 1960's (Seppänen 1970, 1972, 1982, 1986).

In the following we will outline the underlying theories, design principles and goals and present some examples as applied to the subject of this paper, definition and explication of complex concepts, entities and systems involving causality, self-causality and self-reflection in nature and the human spher, that is semiotics and autosemiotics.

The 'Symbolica' and 'Diagraphica' languages consists of several levels of abstraction and complexity as manifested already in the abstract kinds of entities encountered and comprising the field of discrete mathematics, logic and the theory of computation. We define the language elements and notations in terms of a unified notation of the Symbolica language itself. We use also intuitive notations and natural language word and metasymbols in both Symbolica and Diagraphica.

In the following we introduce the levels of Set Theory to Hierarchy Theory which constitute the section entities of different levels of type and complexity. The level of Algebras will not be defined nor discussed in this paper. They are available or can be defined to some extent in all programming languages although nowhere in a unified form yet. The Mathematica system comes closest as to Mathematics.

On the basic levels of mathematics and logic we have adopted traditional mathematical notations and conventions as is the practice in much of the systems and computation sciences, too. We use also some of the variety of the symbolics and notations developed in systems and computation, especially programming and knowledge representation language.

Modern symbolic programming languages since Lisp allow the definition of new notational and syntactic forms and construct of according to the needs and wishes of the programmer or the field of application. Based on the theoretically elegant basis of Lisp it is possible to define entire object and problem oriented languages which have all the already universal facilities of definition, description and computation of Lisp.

Therefore, for designing a universal language all the necessary means and facilities are already there and on can begin from defining entities and systems of entities.

6 Levels of Formal Description

The basic levels of description from the simplest to the the most complex, that is, potentially infinitely complex are:

{Discrete Mathematics
— [Set Theory]
— [Order Theory — combinatorics and emergence]
— [Relation Theory
    — [Sequences and languages]
    — [Graphs and Graph Languages]]
— [Topology — Discrete Topology],
— [Hierarchy Theory — Bubble Theory]
— [Algebras — Theories of
    — [Languages and Grammars]
    — [Mathematics and Logics]
    — [Machines and Computations]
    — [Algorithms and Programs]
    — [Entities and Systems]
    — [Worlds and Minds]}

7 Informal Definition of the Levels of Description

In the following we introduce the levels of Set Theory to Hierarchy Theory which constitute the section entities of different levels of type and complexity. The level of Algebras will not be defined nor discussed in this paper. They are available or can be defined to some extent in all programming languages although nowhere in a unified form yet. The Mathematica system comes closest as to Mathematics.

Hence, the following levels of scale can be identified and defined:

To begin with we denote entities as general class by e and the type of the general class by E.

- [Universe
  - [Time]
  - [Space]
  - [Energy and Matter]]

- [Ontology — Existence — Being
  - Empty Being — Nonbeing
  - Types of Being
    - Occurrence — Event — Happening — Process
    - Becoming — Creation — Birth — Generation — Emergence
    - Being — Existence — Continuity — Identity
    - Disappearing — Destruction — Annihilation — Death
    - Reappearing — Recreation — Rebirth — Reincarnation
    - Causation — Self-causation
      - Cause — Effect
      - Action — Passion
      - Self-action — Interaction]

- [Identity and Type Theory
  - Types of Identity — Individuality — Self — Other
    - Material — Substance — Consistence
    - Spatial — Place — Occupation
    - Temporal — Continuity]

- [Set Theory — Collection — Unordered Set — Composite Existence
  - Types of Entities
    - Entities
      - Elements — Atomic Element — Member
      - Sets — Inclusion — Empty Set
      - Selection — Combination — Subset — Superset
  - Empty Set — ø, {}
  - Nonempty Sets — Elements
    - Sets — Normal Sets — Distinct Elements
      - Singleton — {a} — Soul — Monad
      - Pair — {a,b} — Twins
      - General Set — {a,b,...} — Sisters

    - Multisets — Multiple Identical and Distinct Elements — Bags
      - Empty Multiset — {}
      - Nonempty Multisets — Repetitions — Identical or Distinct
        - Identity Multisets
          - Identity — {a} — Identity Bag
          - Identity Repetitions — {a,a}, ... — Identity Bag
        - Distinctive Multisets — General Bag
          - {a,b} — Normal Sets
          - {a,a,b}, ... — General Bags — Mixed — Woman's Bag
    - Hierarchic Sets
      - Embedded Sets — Recursion
  - Languages and Grammars of Sets and Types]

- [Order Theory — Ordered Set Theory — Sequences — Linear Order
  - Types of Order — Order Relations
    - Before — < — Preorder
    - After — > — Postorder
    - Parallel — = — Nonorder
  - Empty Order — Empty Sequences
    - Empty Order — <>
    - Empty Ordered Pair — <,>
    - Empty Sequence — <,,...>
  - Nonempty Orders — Sequences
    - Arrays — Lists — Permutations
    - Linear Order — Distinct Entity Order
      - Ordered Pair — a < b — General Notation — <a,b>
      - Ordered Triple — a < b < c — General Notation — <,a,b,c>
      - Nonempty Ordered Bags — <a>, <a,a>,<a,b>, ... — Multi Bags
    - Ordered Sequences — (), (a), (a,b), (a,b,...), ... — Lists
    - Multiorder — Identity Entity Order
      - Ordered Identity Multipair — <a1,a2>, ... — Identity Pai
      - Distinctive Multisequence — <a1,b,a2>, ...
      - Alphabets — Repertoire of Symbols
      - Words — Word Forms — Morphology
      - Sentences — Syntax
      - Languages — Syntactic Rules
    - Syntactic Order — Tree Grammars — Classes of Languges
      - Composition — Context — Syntax — Paradigm
    - Hierarchic Order — Embedding — Recursion
  - Languages and Grammars of Sequences]

- [Theory of Relations — Binary Relations — Graph Theory
  - Types of Relations
    - Nondirected — Line, Edge — Symmetric
    - Directed — Arrow
      - Forward —> — Asymmetric Relation
      - Bacward <— — Asymmetric — Reverse — Inverse
      - Interrelations <—> Symmetric

- Empty Relations — Empty Sets, Orders and Relations
    - Empty of Relations — {}, (), []
    - Empty of Entities {—}, (—), [—]
- Nonempty Relations
    - Nondirected Relation
        - Self-relation — [a — a] — Self-pair — Reflexive Relation
        - Interrelation — [a — b] — Edge — Line —
    - Directed Relations — Arrows — Arcs — Transitions
        - Self-relation — [a —> a] — Self-loop — Self-reflection
        - Forward — [a —>b] — Ahead — Onward
        - Backward — [a <— b] — Reverse — Back
        - Bidirectional — [a <—> b] — Interaction — Exchange
- Classes of Graphs — Typology of the Topology of Relations
    - Unordered
        - Pairs — Links — Chains — Trees — Cycles
    - Ordered
        - Arrows — Pointers — References — Arborescences — Circuits
    - Hierarchic Graphs — Graph Grammars
        - Embedded Graphs — Recursion
            - Node-embedded Graphs
            - Line-embebbed Graphs
- Classes of General Relations
    - Unordered and Ordered — Simplexes and Complexes
- Languages and Grammars of Relations]

- [Topology — Dimensionality
    - Types of Topology
        - Dimensionality
            - Mathematical — Abstract
                - Linear — 1-dimensional —Line
                - Planar — 2-dimensional — Surface
                - Spatial — 3-dimensional — Space
                - General — N-dimensional Topological Spaces
            - Special Topologies
                - Spacetime — 4-dimensional Real World Physical Space
        - Type of Dimensionalities — Finity — Infinity — Singularity
            - Open — Flat — Infinite Spaces — Nonclosure
            - Closed — Circular — Singular — Cyclic — Self-closure
            - Mixed — Open and Closed Dimensions — General Manifolds

    - Bubble Theory — Types of Closure
        - Types of Closure
            - Nonclosure — Infinite — Unlimited
            - Self-closure — Circular — Unbounded — N-dimensionas
            - Enclosure — Inside and Outside — N+1-dimensions
        - Dimensionality of Self-closure — Singularity
            - Singularity — Self-encosing Point — 1-dimensional
            - Circle — Self-closing Line — 2-dimensional Enclosure

        - Sphere — Self-closing Surface — 3-dimensional Enclosure
    - Types of Bubbles — Dimensionality — Composition — Complexity
        - Empty — Dot
        - Simple — Sphere — Soap Bubble
        - Compound — Foam
        - Simplicial — n-Simplexes — Simplicial Complexes
        - Complicial — n-Complexes — Complicial Complexies
        - General Manifolds — Topological Complexes
    - Empty Bubbles — Enclosing Boundaries
        - Empty Sets — {} — Enclosed Sets
        - Empty Orders — () — Enclosed Orders
        - Empty Relations — [] — Enclosed Graphs
    - Nonempty Bubbles — {a}, {a,b}, {a,a}..., (a),..., [a], ... — Types
        - Singleton — {(a)} — An Independent Bubble
        - Disjoint — {(a), (b)} — Two Independent Bubbles
        - Tangential — Two Osculating Bubbles — {(a)(b)} — Sequence
        - Compound — Twin Bubble — Triple — Foam
        - Intersecting Bubbles — {(a [b) c]}, ... —
            - Simplex Bubbles — n-Simpexes
                - Chains of Intersections — {a (b}[c)]
                - Trees of Intersections — Named Bubbles
                - Cycles of Intersections — Named Bubbles
            - Complex Bubbles — General Relations of 1-n-Complexes
        - Hierarchical Bubbles — Recursive Bubbles
            - Containing — {((a))}, ...
            - Contained — {(a (b)))}, ...
            - Hierarchies — {(a (b (...)))}, ...
            - Hierarchies of Intersecting Bubbles
        - Bubbles Containing Entities
            - Sets — Unordered — Ordered — Distinct — Multiple
            - Orders — Sequences — Multisequences
            - Relations — Unordered — Ordered
            - Hierarchical — Sets — Orders — Graphs — Relations
    - General Closed Manifolds and Complexes
    - Grammars of Bubble and Manifold Languages]

- [Hierarchy Theory — Type Theories — Simple — General
    - Types of Hierarchy
        - Level — of Entity — Relation — Structure — Form — Function
        - Scale — of Entity — Relation — Strucure — Form
        - Kind — of Entity — Hierarchic Types
        - Degree — of Similarity — Equality
    - Empty Hierarchies
        - Sets — Flat Sets
        - Sequences — Flat Sequences
        - Relations — Flat Relations
        - Bubbles — Flat Bubbles
    - Nonempty Hierarchies — Embedded — Recursive

- Sets — Embedded Sets — General Sets
    - Unordered — Distinct — Multiple
- Sequences — Embedded Sequences
    - Ordered — Distinct — Multiple
- Relations — Embedded Relations
    - Unordered — Ordered
- Bubbles — Embedded Bubbles

- Fractal Theory — Self-similarity
    - Spatial Fractals — Formal Self-similarity
    - Temporal Fractals — Dynamic Self-similarity — Fractal Evolution
- Chaos Theory — Complexity — Aperiodicity — Infinity
    - Spatial Chaos — Aperiodic Order
    - Temporal Chaos — Aperiodic Change
    - Spatiotemporal Chaos — Aperiodic Dynamics — Strange Attractor]

All entities have their individual identity and type or kind which is defined by the class properties which they share with other entities of their kind. Identity is unique to every individual entity of any kind and shared with any two entities and, hence, the ultimate criterion to identify and distinguish an entity from every other entity. The identity is a property of the whole rather than of its parts although all parts also have their identities which are, however, only relative and conditional with respect to other pars and to the whole. This is the fundamental idea of a system and the starting point of system thinking and system philosophy and of subsequent theories and sciences known as systems sciences.

Until now we have defined and discussed only unnamed entities. Indeed, we have used names such as symbols standing for or representing one or another entity but we have adopted these symbols without any explicit naming operation or formal notation for giving a name to an entity, compound of entities or an abstract type or class of entities.

In mathematics symbols are used to name variables, function, classes etc. much in this way. Naming conventions are matters of tradition as to the type of symbols and notations which are usually assumed by default rather than defined except when there is danger of confusion.

In computer programming, instead, names of entities, constants, variables, relations, functions etc. items are explicitly declared or defined by explicit naming by means of special naming forms like variable declaration, value assignment, function definition etc. which forms themselves are formally well defined and have their symbolic notations and syntax in the programming language.

There are special theories about names and naming known as theories of name or name theories which are relevant to many fields and especially to philosophy, mathematics, logic, programming and computation, linguistics and semiotics.

We do not, however, pursue questions of content or notations of name theory or naming conventions used. It suffices us to say that any entity is able to be named independent of whether it is elementary or composite whole of any order, a component of another entity or an abstract entity such as a property, type, class, relation, property of relations, relation of properties, property of properties, relation relations etc. (Seppänen 1982).

The possibility of giving names is useful because it allows entities, and not only entities but their abstract properties, relations etc., to be identified, referred to, called into use or evoked into action by means of a unique name.

8 Abstract and Real World Systems — Mind and Nature

This far we have discussed only abstract mathematical systems, that is, systems which exist in the human mind only but can be described by means of languages between two or more minds and recorded on external media to allow storage over time and time-independent consultation.

The Symbolica language is, however, not designed only for the purposes of discussion of abstract concepts but also for the discussion of real world phenomena and systems and both in unified fashion as is the case with natural languages. This is possible on the basis of the fact that the mind itself is a natural phenomenon capable of reflection and self-reflection of the nature and itself in terms of mental images, concepts and thinking.

It is only necessary to correctly relate the mind, language and nature and their causal and self-causal relations between and within the three principal systems. This is precisely the aim of semiotics and more generally of autosemiotics.

The classical and modern semiotics have, however, been dealing only with human semiotics, that is interpretation of human cultural and mental issues, and more recently issues concerning human interpretation of animal life and behavior known as zoosemiotics and biosemiotics as well as of nature known as natural semiotics.

Autosemiotics, however, is a still wider view of semiotics which is not restricted to the living nature of human and animal minds in the role of an interpreter of the phenomena and objects of their environmental as signs, texts etc. but also nonliving objects of the nature in the role of interpreters of their environments in their interactions.

Such a view of nature and generalization of semiotics is justified on the basis that any interpretation an expression of meaning in a mind and any interaction in nature, whether living or nonliving, are causal phenomena or processes, albeit of different order of complexity and causal and self-causal organization of the interplay of matter and energy in the nature.

In the following we shall consider and lay down the outline of the constitutional and causal complexity from the simplest interactions in the nonliving nature to the levels of the living, mental and cultural phenomenal spheres.

Of crucial importance to the possibility of bridging this phenomenal and the yawning explanational gap are the principles of self-causality and self-complexification underlying all systems theories sine qua non. Therefore, we shall introduce if only by name the hierarchy of systems theories and sciences which constitute an inevitable prerequisite for understanding and explaining anything about complexity or evolution of complexity, that is, self-complexification and self-diversification of nature by itself.

In this view semiotics as a science is a systems science among a number of other systems sciences in a hierarchy of an array of a dozen or so specificas to ther phenomenology but universal as to their applicability and capability of explanation of different classes of complex phenomena.

Then, autosemiotics in its turn, is the view of semiotics generalized to the entire universe as giving meaning and interpreting itself within and across all levels of its self-complexity and self-complexification.

9 Systems — Causality and Complexity

The system level notions and metalanguage conventions of Symbolica are based on the notions and theories of the respective systems sciences, notably, the following main levels:

— [Systems
  — [Abstract Conceptual Systems
    — [General Systems Theory]
    — [Systems Philosophy]]
  — [Real Systems — [Cosmos [Nature]]
    — [Static Systems Theory]
    — [Kinetic Systems Theory]
    — [Dynamic Systems Theory
      — [Cybernetic Systems
      — [Stabilizing — Self-stabilizing Systems]
      — [Regulating — Self-regulating Systems]
      — [Communicating — Self-communicating Systems]]
      — [Organizing — Self-organizing Systems]
      — [Producing — Self-producing Systems]
      — [Sentient — Self-sentient Systems]
      — [Modelling — Self-modelling Systems]
      — [Learning — Self-Learning Systems]
      — [Cognitive — Self-cognitive Systems]]]]

We do not discuss in this paper any specific systems theories which comprise a huge tradition although conceived as independent methodological science only half a century ago. The term 'system' and systems concepts and systems thinking have been used by man from the times unknown in everyday life, religions, philosophy, sciences and specially in engineering. Aristotle discussed the concept of a system in natural philosophy, Galilei introduced the term to science as 'systema cosmicum' (1632) and the Austr. theoretical biologist Ludwig von Bertalanffy founded systems theory as a field of its own (1948).

After the 2nd World War a wealth of systems theories and sciences began to prolify and continue to develop in an explosive manner. The systems sciences have not, however, been unified yet because they are very complex and are not yet fully understood, especially their relations are still in many respects unclear.

The author has been involved in systems sciences and systems engineering since the early 1960s and been intrigued from the very beginning with the interrelations of the classical and the ever new special theories and fields of systems sciences which continue to emerge and in bringing them into some rational overall conceptual framework. This is the subject also of this paper, unification of the classical and modern systems sciences and with the systems sciences al sciences.

This goal is not at all unrealistic since systems sciences are the sciences which deal with complexit and the world and the complexity of the world are finite ad most of the natural sciences have already solved the basic but simple problems about nature and cosmos. IT only remains to solve the complex problems which remain in life, human and cultural sciences most of which are after all also simple with the exception of the fundamental problems of life and mind which are the keys to the solution of all other problems.

In this paper we approach these questions and goals from the point of view of developing a unified semiformal and seminatural language for conceptual analysis and description of complex natural systems irrespective of the phenomenal sphere. The language should allow to clearly define scientific concepts and to describe the overall constitution of the world according to the scientific worldview offered today by the classical and modern special sciences and the methodologically interdisciplinary systems sciences.

The Symbolica language is designed so as to allow to unify the descriptions required by the classical and modern mathematical and the special natural, life, human and cultural sciences together with the systems sciences. Such a description language should allow to construct the scientific worldview in a correctly organized form and in a disciplined manner.

The notations of the metalanguage necessary for the definition and description of the systems theories are minimal since they already belong to the subject matter rather than metalanguage design. The same is true with respect to any field of application from elementary particle physics to cosmology and from atoms to molecules, man and beyond, mind, languages, societies and cultures and natural and cultural history of the human civilization.

The Symbolica language allows to describe any kind of entities in the known universe in terms of a semiformal natural language in a structured and disciplined way as declarative and functional definitions as in computer programming.

In fact, when implemented on computer, the Symbolica language becomes unified language of science which is equally readable to men and machines. Until its implementation it is only a language for the facilitation of human analysis, understanding, explanation and design of complex systems. It is most useful also for teaching and education of complex phenomena, theories and to disseminate the scientific world view and conception of man.

The fairly limited set of basic mathematical theories supplemented and unified with the essential theories of systems and computer sciences allow to define unordered and ordered sets of entities, composite entities, bubbles, relations and systems of entities involving causal relations — simple, branching, joining, linear, acyclic, cyclic, hierarchic, recursive and indefinitely complex forms of causality and self-causality — to be defined and describe using freely natural language words and problem-close scientific terms and notions to any level of organization and complexity in a conceptually natural ans elegant way.

In important design principle of the language, and not only of its design but also of its use, is the principle of natural language words, terms and names as identifiers of the entities and systems all of which are completely free for the language user to choose not violating the metasymbol syntax.

10 Constitution of the World — Levels of Autosemiosis

Constitution of the World — Systems Paradigm of the
— Unified Science and the
— Methodology of Unified Science

We will now turn to the main topic of the paper, to define and describe the notions and meaning of semiosis as a human and autosemiosis as a universal principle of self-reflection in nature. For the purposes of clarity and to get a concise outline and overview of the contents at each level of scale and complexity we apply the top down principle as our method of approach.

Thus, we first break down the entire universe according to hierarchies of scale and complexity of constitution of the world into the fundamental phenomenal levels. Each level has its specific phenosphere has its characteristic and different qualities and consequently respective laws, theories and sciences.

Hence, the following levels of scale can be identified and defined:

— [Universe
[Cosmic
[Astronomical
[Galactic
[Solar
[Terrestrial
[Physical
[Chemical
[Biological
[Neural
[Mental
[Linguistic
[Social
[Political
[Cultural including
[Mythology
[Religion
[Occultism
[Philosophy
[Science
[Technology
[Art]]]]]]]]]]]]]]]]]]]]]]

The cosmic level can now be defined as:

- [Cosmos <— ['Big Bang'] —> [Expansion —> [Entropy]] —>
[Radiation —> [Solitons —> [Elementary Particles] —>
[Strong Nuclear Force <—
[Weak Nuclear Force <—

[Electromagnetic Interactions] <—
[Electromagnetic <—
[Light Atoms <— [Nucleosynthesis]
[Gravitation —>
[First Order Stars —
[Nuclear Synthesis —>
[Second Order Stars —>
[Supernova —>
[Heavy Atoms —> [Galaxies]]]]]]]]]]]]]

The astronomical level can be further detailed as:

- [Astronomy —> [Gravitation]] —>
[Interstellar Dust —> [Galactic Nuclei —> [Galaxes <—
[Stellar Genesis —>
[Planetary Discs —> [Planetary Systems —>
[Planets —> [Geological Evolution —>
[Vulcanism —>
[Geophysic —>
[Geochemistry —>
[Chemistry]]]]]]]]]

The level of atomic physics and chemistry can be broken down as:

— [Atomic Physics
[Chemistry <— [Weak Nuclear Force <—
[Electromagnetic Force <— [Entropy] —>
[Heat <— [Kinetic Energy] —>
[Pressure <—
[Concentration —>
[Diffusion
[Chemical Potential —>
[Spontaneous Reactions <— [Affinity] —>
[Catalysis <— [Side Effect] —>
[Autocatalysis —> [Explosions] —>
[Biotic Systems]]]]]]]]]]]]

The level of living systems and biological phenomena is overwhelmingly complex and diverse and involves a great number of levels, branches and directions of evolution and coevolution, all of which manifest, however, the same underlying principle of autocatalysis, and speciation and their symbiosis and coevolution with their living environment as habitats, kenoses and ecologies:

— [Biogenesis ['Creation' — Self-conception] —> Biotic Systems
[Life —> [Biology —> [Life Sciences]]] —>
[Origins of Life —> [Evolution of Life —>
[Catalysis —> [Autocatalysis —>

[Nuclear Autocatalysis —> [Nucleosynthesis —>
[Nuclear Life Forms —> [Abiotic Nuclear Life —>
[Linear Autocatalysis — [Nuclear Self-reproduction]]
[Branching Autocatalysis — [Nuclear Explosion]]
[Cyclic Autocatalysis —>
[Hypercyclic Autocatalysis —>
[Evolution of Abiotic Nuclear Life]]]]

[Chemical Autocatalysis —> [Abiotic Chemical Life —>
[Chemical Life —> [Autocatalytic Systems —>
[Linear Autocatalysis — Chemical Self-reproduction]
[Branching Autocatalysis — Chemical Explosion]
[Cyclic Autocatalysis —> Cyclic Self-reproduction]
[Hypercyclic Autocatalysis —>
[Evolution of Abiotic Chemical Life]]]]]

[Virogenesis —> [Exolife — Open Self-reproduction]
[Viroevolution]] —>

[Vesicogenesis —> [Membranogenesis —>
[Virovesicular symbiosis —>
[Cytogenesis —> [Cell — Self-reproduction]
[Biotic Chemical Life —> [Coevolution —>
[Unicellular Chemical Life Forms —>
[Archebacteria —>
[Prokaryota —>
[Eukaryota —> Cytoevolution]]]]]
[Multicellular Chemical Life —>
[Cytosymbiosis —>
[Colonial Evolution —>
[Organismic Evolution —>
[Differentiation —>
[Exodifferentiation] <—>
[Endodifferentiation
[Symbiosis —>
[Exosymbiosis] <—>
[Endosymbiosis]]]]]]]]]

[Metabologenesis —> [Metabolism —>
[Exometabolism —>
[Endometabolism —>
[Catalytic Metabolism —>
[Autocatalytic Metabolism —>
[Anabolism <—> Catabolism] —>
[Metabolic Cytoevolution]]]]]]]

[Aminogenesis —> [Aminoacids —>
[Exoaminoacids —>

[Endoaminoacids —>
[Catalytic Proteosynthesis—>
[Autocatalytic Proteosynthesis —>
[Proteomic Life — Protein World] —>
[Proteomic Cytoevolution]]]]]]]

[Nucleinogenesis —> [Nucleic Acids] —>
[Exonucleic Acids —>
[Endonucleic Acids —>
[Catalytic Nucleinosynthesis —>
[Autocatalytic Nucleinosynthesis —>
[Nuclonic Life —> RNA World
[Proteomic Cytoevolution]]]]]]]

[Genogenesis —> [Genoevolution — [Heredity] —>
[Genoproteomic Symbiosis —>
[Exocytotic Genoproteomic symbiosis —>
[Endocytosymbiosis]]]—>

[Mutogenesis —> [Genetic Mutation] —>
[Exomutosis —>
[Endomutosis —>
[Endogenoevolution]]]]

[Genoproteomic Symbiosis —> [Genetic Evolution —>
[Exocytotic Genoproteomic Evolution —>
[Endocytotic Genoproteomic Evolution —>
[Biotic Evolution —>
[Unicellular Genetic Evolution —>
[Prokaryotic Evolution —>
[Eukaryotic Evolution]]] —>
[Multicellular Evolution —>
[Prokaryotic Evolution —>
[Eukaryotic Evolution]]]] —>
[Uni-multicellular Symbiotic Evolutio —>
[Eukaryoprokaryotic Symbiotic Evolution]]]]]

[Sexogenesis —> [Sexual Evolution]

[Speciogenesis —>
[Specioevolution —>
[Ontogenesis —>
[Ontogenetic Evolution —>
[Phylogenesis —>
[Phylogenetic Evolution]]]]]]]]]

The level neural and mental phenomena and systems based on the evolution of biotic systems is increasingly complex and diverse and involves a great number of levels, branches and directions of evolution and coevolution.

These consist of the sensory, neural, cerebral and mental systems, all of which manifest, however, the same underlying principle of reflection of their external experience of their living environment and self-reflection of their internal self-experience by means of the internal sensory and hormonal systems, self-sentience and introspection, and their symbiosis and coevolution with their habitats, kenoses, ecologies, societies and cultures.

— [Neurogenesis —> [Soma —> [Neuron —> [Memory]] —>
[Ennervation —> [Neural Pathways —> Neural Network]] —>
[Encephalation —> [Perception] —>
[Afferent Excitation — [Sensation] —>
[Attention] —> [Apperception] —>
[Mentogenesis —> [Mind —> [Mental Systems —>
[Noogenesis —> [Noosphere —>
[Comprehension] —>
[Thought —> [Conception] —>
[Awareness —>
[Self-Awareness —>
[Consciousness —>
[Self-consciousness]]]]]]] —>

[Language and Communication —>
[Behavioral —>
[Gestural —>
[Mimical —>
[Signal —>
[Indicial —>
[Symbolic —>
[Verbal]]]]]]] —>

[Focalization —> [Volition —>
[Efferent Excitation —>
[Neurocatalysis —>
[Motor Action —>
[Action —>
[Artefaction —> Culture]]]]]]

The level of cultural systems based on mental systems is increasingly complex and diverse and involves great number of levels and directions and branches of evolution of the sensory, neural and cerebral systems, all of which manifest, however, the same underlying principle of reflection of their experience of their living environment and self-reflection of their internal self-experience by means of their internal sensory and hormonal systems and their symbiosis and coevolution with their habitats, kenoses, ecologies, societies and cultures.

[Cultogenesis —> [Culture —>
[Social Culture <—> [Sociosphere <—>
[Gathering —>
[Hunting —>
[Nomadism —>
[Cultivation —>
[Handicraft —>
[Industry]]]]]] —>

[Material Culture —> [Things —> [Products —> Tools]]]
[Building —> [Nests —> [Homes —> [Buildings]]]
[Production —> [Productosphere —>
[Natural Implements —> [Tools —> [Technosphere
[Devices —> [Machines —>
[Automata —> [Robots —>
[Universal Computers —>
[Universal Robots]]]]]]]]]]] —>

[Mental Culture <—> [Noosphere <—>
[Animism —>
[Magic —>
[Shamanism —>
[Totemism —>
[Mythology —>
[Religion —>
[Theology —>
[Philosophy —>
[Science —>
[Technology]]]]]]]]]

[Creativity —> [Intellection —>
[Thought —> [Intellectosphere —>
[Imagination —> [Imagosphere —>
[Art —> [Artosphere —>
[Mythology —> [Mythosphere —>
[Religion —> [Credosophere]]]]]]]] —>
[Philosophy —> [Ideosphere —>
[Science —> [Noosphere —>
[Technology —> [Technosphere]]]]]]

[Art —> [Imagination —> [Imagosphere —>
[Mental Art <—>
[Exoart —[Material <—>
[Discovery <—> [Invention <—>
[Imagination <—> [Imagosphere]]] <—>

[Behaviour <—> [Behaviosphere <—>
[Bodily Art <—>

[Action —> Actosphere <—>
[Bodily Performing Art <—>
[Dance —> [Choreosphere <—>
[Singing <—>
[Playing — Music] <—>
[Theatre]]]]

[Faction <—> [Factosphere <—>
[Work <—> [Physical — [Mental
[Artefaction <—>
[Physical Culture <—>
[Technosphere <—>
[Artosphere]]]]]]]]]]

[Material Art —>
[Handicraft Art Forms —>
[Natural Art —> [Manual Without Using Tool —>
[Medial Art Forms —> [Using Tool —>
[Architecture —> [Nests, Huts, Houses]
[Sculpture —> [Tombs, Statues] —>
[Decoration —> [Objects, Clothes] —>
[Drawing —> [Carving] —>
[Painting —> [Rock, Cave]
]]]]]]

[Technical Art Forms —>
[Photography —>
[Radio —>
[Television —>
[Computer —> Virtual reality
[Net — Virtual Net Reality]]]]]]

[Science —> [Intellection —>
[Discovery —> [Noogenesis —> [Noosphere]]]]]

[Technology —> [Intellection —>
—> [Invention — [Technogenesis —> [Artefaction]]]]

The above classification and description has been refined over several versions of a scientifically organized thesaurus of the Finnish language (Seppänen 1985) but appears here only for purposes of demonstration of the complexity of the world and respectively of science as a whole even on a high conceptual level. The possibility of organizing and presenting all of science within one conceptual scheme witnesses, however, that it is possible and realistic to pursue the ideals of unified science.

11 Conclusions

We have outlined the principles for the development of a universal concept technology, based on the Lisp ideology, for the design, representation and description of symbolic systems and models standing for anything, real or abstract, in two conspicuous and natural like formal languages, one diagrammatic called 'Diagrammatica and the other symbolic and called 'Symbolica', both equal as to their potential representational and computational power.

'Diagrammatica' combines and formalizes the key elements and aspects of systems any description and modelling languages, the structural and functional description of objective and subjective systems including worlds and world models as well as selves and self-models, including models needed in computational linguistics, artificial intelligence, cognitive science and consciousness studies in human, animal and machine systems.

Complex conceptual systems of any degree limited only by human ability to comprehend and manage can be defined and represented in terms of conspicuous and logically and computationally equivalent diagrammatic and symbolic mathematical formula and programming languages and grammars in a unified fashion to allow their use equally by humans and computers in both graphical and symbolic form.

The symbolic formula language is based on and cover the fundamental levels of discrete mathematics — set theory, combinatorics including formal languages, graph and automata theory, theory of relations, hierarchy and recursion theory, simple combinatorial bubble theory and topology and the level of general systems, information and computation theory — all levels being freely reentrant.

The motivation and need for a unified concept technology and a natural-like visual representation and computational language framework for organization, structuring and description of the ever exploding worldwide knowledge is becoming a bottleneck to the evolution of the noosphere and the utilizaation of the noological resources of the civilization.

According to the scientific worldview all knowledge, scientific or not, can be organized in indefinitely diverse idiosynchretic fashions and system architectures as witnessed by individual worldviews, conceptions of man, gods, angels etc. in mythology, religions, occultism, philosophy, science, technology and culture.

For all human knowledge there is, however, only one world and consequently ultimately only one true and correct world view which comes closest to the objective reality and the subjective realities which allow different conceptions but can still equally be assigned their correct category in the scientific classification of knowledge and the scientific world view.

This idea and goal was originally formulated by the Vienna Circle philosophers of science and scientists in the early modern science when classical physics seemed to have been finished and finalized and scientists and philosophers began to dream of the unification also of modern physics and subsequently of the rest of sciences. The initiative was made by Albert Einstein in proposing the concept of 'unified theory' (1925, 1935) which the Vienna Circle took over and generalized into 'unified science' adding the notion of 'scientific worldview' and initiating the international programme of 'Unified Science' (1931).

As is well-known, the programme failed and came to an end in 1938 for several reasons, both external and methodological, for the latter because physicalism and logical empiricism turned out to be a reductionistic methodology. Physics and logic alone were revealed incapable of explaining qualitative and systemic phenomena, complex simultaneous effects and continuous functions which depended on the qualities, relations and organization and appeared unpredictable to classical and modern physics.

Today, along with the development of the computer and the systems, information and computation theories and the sciences of complexity these shortcomings have become understood and appreciated. Equipped with the new paradigm methodology of science it is becoming possible to address by exact methods not nly physics but also phenomena of chemistry, biology, neurology, psychology and language, which constitute also the foundation for social and cultural sciences although specific new qualities and phenomena arise also on these higher phenomenal levels.

During and after the 2nd World War the array of new sciences, the systems, information and computation sciences have evolved into a new and universal paradigm of the methodology for all sciences, not only relevant but absolutely necessary for every field of knowledge, and not only as an applicable methodology for disparate disciplines but also capable of their conceptual, methodological and theoretica, and ultimate, of scientific unification.

The internat and web technologies have converted the entire world into a global library, laboratory and computer and communication centre where in principle everybody can access any scientific as well as nonscientific knowledge. It is the scientists and engineers who have developed the information and communication and it now remains their responsibility and challenge to take the next step, to develop the languahge, concept, intelligence and consciousness technologies and the framework for the unified science, scientific worldview and human conception.

References

Graph Theory

1. Seppänen J. (1970): Verkkojen teoriaa ja sovellutuksia. TKK, Tietojenkäsittelyopin laitos, No C 6, OtaDATA, Espoo.
2. Seppänen J. (1971): Verkkojen teoriaa, algoritmeja ja sovelluksia. TKK, Tietojenkäsittelyopin laitos, No C9, OtaDATA, Espoo.
3. Seppänen J. (2001): Verkkoteorian historia ja filosofia. Hämähäkin seitistä hermoverkkoon ja verkkoälyyn. Tieteen ja tekniikan historia ja filosofia — Diskreetti matematiikka, Tietotekniikan osasto, TKK, Espoo.

Systems Analysis

1. Seppänen J., Moore J.M. (1969): Facilities Planning with Graph Theory. Helsinki University of Technology, The Institute of Information Processing Science, No B1, OtaDATA, Espoo.
2. Seppänen J. (1970): Facilities Planning with Graph Theory. Management Science, Vol. 17, No. 4, Journal of the Institute of Management Science.
3. Seppänen J., Moore J.M. (1975): String Processing Algorithms for Plant Layout Problems. Int'l Journal of Production Research, Vol. 13, No. 3.

Knowledge Representation

1. Seppänen J. (1970): Spanning Tree. Algorithm 399, Communications of the ACM, Vol. 13, No. 10, Oct. 1970
2. Seppänen J. (1982): Hierarchic Class Networks: A Diagrammatic Graph Formalism for Natural Language Modelling. The XIII International Conference of Linguists 29 Aug.-4 Sept. 1982, Tokyo.
3. Seppänen J. (1982): Luokkaverkot kielenohjelmoinnin suunnittelukielenä. Suomen kielitieteen päivät, 13-14.2.1982, Suomen soveltavan kielitieteen yhdistyksen (AFinLA) julkaisuja, Sajavaara K. et al., eds., Jyväskylä.
4. Seppänen J. (1983): Hierarchic Class Networks for Natural Language Description and Knowledge Representation. In: Narinyani A.S., red., Razrabotka i primenennie lingvisticheskih processorov, Akademija Nauk, Sibirskoe otdelenie, Vycislitelnyi Centr, Novosibirsk.
5. Seppänen J. (1986): Merkitys ja tulkinta koneälytutkimuksen valossa. Suomen Semiotiikan Seuran 5. Symposio, Imatra 22.7.1986, Synteesi 4/86.

Information Retrieval

1. Seppänen J. (1971): Informaation etsintä luonnollisen hakusanan perusteella. Teoksessa: Roman I. Tietopalvelu (Information Retrieval), Tietojenkäsittelyopin laitos, TKK, Otaniemi.
2. Seppänen J. (1976): Symbolic Association of by Word Rotation in Nested Ordered Binary Tree Structure. NordDATA-76 Conference, Otaniemi.

User Interface

1. Seppänen J. (1971): Pragmatic Problems of Man/Computer Dialogues. Journal of Pragmatics, 6/1982.
2. Seppänen J. (1977): Videoclavis —A Universal Programmable Human Interface. HUT Computing Centre, No 25, Otaniemi.
3. Seppänen J. (1977): Design Principles for Tactile Display Dialogues. HUT Computing Centre, Research Report, No 1, Otaniemi.
4. Seppänen J. (1980): Soft Display Key for Kanji Input. COLING-80, Int'l Conference on Computational Linguistics, 30 Sept.-4 Oct. 1980, Tokyo.
5. Seppänen J. (1986): On the Role of Self and Self-Knowledge in Man-Machine Systems. No. 29, HUT Computing Centre, Espoo. Also n: Uuspää P., ed.Advances in Man-Machine Interactions, The Joint Soviet-Finnish Symposium on Man-Machine Interface, Control Rooms and Expert Systems, Espoo, Oct. 21-23, 1986.

Symbolic Computation — Lisp

1. Seppänen J. (1972): Lisp kielenopas. TKK Tietojenkäsittelyopin laitos, No D6, OtaDATA, Otaniemi.
2. Hyvönen E., Seppänen J. (1986): Lisp-maailma 1-2. 1. Johdatus kieleen ja ohjelmointiin. 2. Ohjelmointimenetelmät ja järjestelmät. Kirjayhtymä, Helsinki.
3. Hyvönen E., Seppänen J. (1989): Mir Lispa 1-2. Izdatelstvo Mir, Moskva.

Computational Linguistics

1. Seppänen J. (1972): Presedenssilauseoppien analyysi- ja lauseenjäsennys. Teoksessa (Seppänen 1972).
2. Seppänen J. (1982): Recursive Functions for Computation of Natural Secret Languages. COLING 82 — 9th Int'l Conference on Computational Linguistics, Prague.
3. Seppänen J. (1982): Computing Families of Natural Secret Languages. An Excercise in Functional Linguistics. HUT Computing Centre, No 23, Espoo.
4. Seppänen J. (1985): Tietokoneestako kieliniekka? Ohjelmoimme leikki- ja salakieliä. Nokian Opetusjärjestelmien asiakaslehti Noppi, Helsinki.

5. Seppänen J. (1989): Special Hardware and Future Development in Computer Architecture in View of Computational Linguistics. In: Bátori I. et al., eds., Computational Linguistica —Computerlinguistik, Walter de Gruyter, Berlin.
6. Seppänen J. (1998): Malliajattelu tilanne- ja merkityssuhteiden luokittelun perustana. XXV Kielitieteen Päivät, Tampere 15-16.5.1998.

Computer and Communication Networks
1. Korpi M., Roos M., Seppänen J. (1974): Datavaihde Otaniemen tietojenkäsittelyverkossa. TKK Laskentakeskus, Teknillinen sarja, No 17, Espoo.
2. Seppänen J. (1982): Tietokonevälitteisen tiedeviestinnän typologiaa. Näkökulma informaatiojärjestelmien kierteissumuun. Kirjastotiede ja informatiikka 1:2/82.

Computer-aided Language Learning and Teaching
1. Seppänen J. (1980): Japanin kieli ja merkillinen kirjoitusjärjestelmä. Suomalais-Japanilainen Yhdistys, Julkaisu No 1, Helsinki.
2. Seppänen J. (1980): Japanin kielioppi. TKK Kielikeskus, Espoo.
3. Seppänen J. (1986): Introducing Microcomputers to Language Learning. In: Kecskés I., Papp F., eds., Int'l Symposium on Linguistics and Methodology in Computer Assisted Language Learning, Kossuth Lajos University, Debrecen, Nov. 12-13, 1985.
4. Seppänen J. (1987): Kielet ja kirjoitusjärjestelmät. Tietokone symbolisessa grafiikassa ja viestinnässä. Teknillisen korkeakoulun kielikeskus, Espoo.
5. Vaario J., Seppänen J. (1987): Kanji Sensei — An Intelligent Kanji Tutoring System. Int'l Conference on Japanese Information, University of Warwick, 1-4. Sept, 1987, Warwick.

Systems and Information Sciences
1. Seppänen J. (1998): Systems Ideology in Human and Social Sciences. History and Philosphy of System and Model Thinking, Information Theory and Cybernetics. In: Altmann G., Koch W.A., eds. (1998), Walter de Gruyter, Berlin and Nerw York.
2. Seppänen J. (2001): Systems Ideology and the Unity of Science. Toward an Integral Postdisciplinary Scientific Worldview. XXIst International Congress of History of Science. Mexico City, 8-14 July 2001.
3. Seppänen J. (1998): History and Philosophy of Emergence, Self-organization and Complex Dynamics. HUT History and Philosophy of Science — Systems Sciences, Department of Computer Science, HUT, Espoo.

Awareness and Consciousness Studies
1. Seppänen J. (1999): Luonto, mieli ja tieto. Teoksessa Ketvel et al., eds. (1999): Avartuva ajatus, Luonnonfilosofian seuran julkaisuja IV, Helsinki.
2. Seppänen J. (2001): The Mandelbrot Set as a Metaphor of the Human Body, Brain and Mind. The Place of Consciousness in Nature. Towards a Science of Consciousness, 7-11 Aug. 2001, Skövde.
3. Seppänen J. (2002): Ipsology — Toward a Science of Self. A Postdisciplinary Concept History and Philosophy (Forthcoming).

Scientific Worldview and Human Conception
1. Seppänen J. (1985): Arpakannus — muinaissuomalaista tietotekniikkaa. Tekniikan Waiheita, No 1/85.
2. Seppänen J. (1985): On Logico-semantic Classification of Common Sense Words and Concepts. ASV-85 — Automatische Sprachverarbeitung, 25-29 März 1985, Berlin.
3. Seppänen J. (1986): I Ching — muinaiskiinalainen hyperteksti. Synteesi 4/86.
4. Seppänen J. (1990): Kaaos luonnossa, kulttuurissa ja tajunnassa. Uudet 'epätieteet' laajentavat maailmankuvaamme. Suomen Semiotiikan Seuran 9. Symposiumi 19-20.7.1992, Imatra.

5. Seppänen J. (1992): Etymologia, mytologia ja kosmologia. Kielen, mielen ja maailmankuvan rajoilla. Suomen Semiotiikan Seuran 11. Symposiumi, 17.7.1992, Imatra.

Worldwide Knowledge — Web Intelligence

1. Seppänen J. (2001): Verkkoäly ja maailmankuva — Miten jäsentää maailmanlaajuinen tieto? Semantic Web Kick-off in Finland — Älykäs www Suomessa. Helsingin yliopisto, Porthania 2.11.2001, Helsinki. Esitelmämoniste.
2. Seppänen J. (2004): Semiotica — Semiotics as a Systems Science. Object, Sign and Concept — World, Mind and World View. History and Philosophy of Science and Technology, Department of Computer Science, Helsinki University of Technology, Espoo.
3. Seppänen J. (2004): Natural Language Thesauri as Cladistics of Nature. Semantic Categories of Natural Languages and Worldviews. History and Philosophy of Science and Technology, Department of Computer Science, Helsinki University of Technology, Espoo.
4. Seppänen J. (2004): Diagraphica — a Universal Grammar of Knowledge. Unified Informal Analysis and Design Language for Concept Technology. History and Philosophy of Science and Technology, Department of Computer Science, Helsinki University of Technology, Espoo.
5. Seppänen J. (2004): Symbolica — A Universal Algebra of Knowledge. Unified Algebra and Definition Language for Concept Technology. History and Philosophy of Science and Technology, Department of Computer Science, Helsinki University of Technology, Espoo.
6. Seppänen J. (2004): Noologica — a Unified System of Unified Science. A Constitution and Epistemology for the Systems Paradigm of Unified Science. History and Philosophy of Science and Technology, Department of Computer Science, Helsinki University of Technology, Espoo.

History and Philosophy of Science and Technology

1. Seppänen J. (2000): Tieteiden yhdentyminen antiikista nykyaikaan. Yhtenäisteorioiden esihistoria, historia ja filosofia. TKK, Espoo
2. Seppänen J. (2001): Ajattelun historia ja filosofia. Tiedonpuu, maailmankuva ja ihmiskäsitys. Opetusmoniste, Tieteen ja tekniikan historia ja filosofia, TKK.
3. Seppänen J. (2004): Tieteen ja tekniikan historia ja filosofia. Oppiaineen ja opetushjelman esittely 2004/2005. Tietotekniikan osato, TKK, Espoo.