Title
Three levels of the symbolosphere

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The Symbolosphere and the Structure of the World

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ABSTRACT

This work is aimed at explanation of coexistence of material and nonmaterial aspects of life. It is demonstrated that by synthesizing ideas about structures, physical entities, mental phenomena, and symbolic relations, it is possible to understand how the nonmaterial can emerge from the material and in which way the nonmaterial may mediate and control the production of material entities. Found regularities form a cyclic structure, which is applied to the phenomena of creativity and invention.

Keywords: symbol, structure, matter, mentality, semiotics, creativity

1. Introduction

Mind and soul versus material/physical entities. Scholars have always debated the existence of material and nonmaterial worlds. The nonmaterial realm has generally been referred to as mind or soul. The former generally has referred to psychological or mental domains and the latter to spiritual aspects of life. The nonmaterial is difficult to account for, and therefore, it has been convenient for many scholars to take a reductionist stand that considers the only legitimate reality to be the material.

In this paper, we attempt to reclaim the nonmaterial aspects of our existence. We first present a formulation for the global features of the world (physical, structural, and mental), and then we argue that the nonmaterial domain is located most profoundly in symbolic relationships where signs accrue meaning by reference to other signs. Our point is to assert that as the symbolic species (Deacon, 1997) we inhabit a world that is both material and nonmaterial. The latter emerges from the former and is always related to the former, but nevertheless the nonmaterial constitutes a domain of existence with its own characteristics and with the ability to exert downward influence on the material domain.

2. The Global Structure of the World

We all live in the physical (material) world and many perceive that this is the only reality that exists. However, some Eastern philosophical and religious systems, e.g., Buddhism, teach that physical reality is a great illusion and the only reality is the spiritual world. As science does not have enough evidence to accept or reject this idea, we are not going to discuss it. Nevertheless, science has enough evidence to accept existence of the mental world. As states contemporary psychology, each individual has a specific inner world, which is based on the psyche and forms mentality of the individual. These individual inner worlds form the lowest level of the mental world, which complements our physical world.

Some thinkers, following Descartes, consider the mental world as independent of the physical world. Others assume that mentality is completely generated by physical systems of the organism, such as the nervous system and brain as its part. However, in any case, the mental world is different from the physical world and constitutes an important part of our reality.

Moreover, our mentality influences the physical world and can change it. We can see how ideas change our planet, create many new things and destroy existing ones. Even physicists, who research the very foundation of the physical world, developed the, so-called, observer-created reality interpretation of quantum phenomena. A prominent physicist, Wheeler, suggests that in such a way it is possible to change even the past. He stresses (Wheeler et al, 1983) that elementary phenomena are unreal until observed. This gives a dualistic model of reality.

However, the dualistic model is not complete. This was prophesized in ancient Greece and proved by modern science. One of the great ideas of ancient Greece is the world of ideas (or forms), the existence of which was postulated by Plato. In spite of the attractive character of this idea, the majority of scientists and philosophers believe that the world of ideas does not exist, because nobody has any positive evidence in support of it. The crucial argument of physicists is that the main methods of verification in modern science are observations and experiments, and nobody has been able to find this world by means of observations and experiments. Nevertheless, some modern thinkers, including such outstanding scholars as philosopher Karl Popper, mathematician Kurt Gödel, and physicist Roger Penrose, continued to believe in the world of ideas, giving different interpretations of this world but suggesting no ways for their experimental validation.

However, science is developing, and this development provided recently for the discovery of the world of structures. On the level of ideas, this world may be associated with the Platonic world of ideas in the same way as atoms of modern physics may be related to the atoms of Democritus. The existence of the world of structures is demonstrated by means of observations and experiments. This world of structures constitutes the structural level of the world as whole. Each system, phenomenon, or process either in nature or in society has some structure. These structures exist like things, such as tables, chairs, or buildings, and form the structural level of the world. When it is necessary to investigate or to create some system or process, it is possible to do this only by means of knowledge of the corresponding structure. Structures determine the essence of things.

In the Platonic tradition, the *global world structure* has the form of three interconnected worlds: *material*, *mental*, and the *world of ideas* or *forms*. However, existence of the world of ideas has been severely criticized. Many argue that taking a long hard look at what the Platonist is asking us to believe, we must have faith in another “world” stocked with something called ideas. Where is this world and how do we make contact with it? How is it possible for our mind to have an interaction with the Platonic realm so that our brain state is altered by that experience?

Popper's ontology consists of three worlds:

World 1: Physical objects or states.

World 2: Consciousness or psychical states.

World 3: Intellectual contents of books, documents, scientific theories, etc.

As Popper uses the words "information" and knowledge interchangeably, World 3 consists of knowledge and information.

Other authors refer World 3 to signs in the sense of Charles Pierce, although they do not insists that consists of objects that Pierce would classify as signs (cf., for example, (Skagestad, 1993; Capuro and Hjorland, 2003)).

Only recently, modern science made it possible to achieve a new understanding of Plato ideas, representing the *global world structure* in the form of the existential triad of the world. In this triad, the material world is interpreted as the physical reality, while ideas or forms might be associated with structures, and the mental world encompasses much more than individual conscience (Burgin, 1997; Burgin and Milov, 1999). In particular, the mental world includes social conscience. In addition, the World of structures includes Popper's World 3 as knowledge is a kind of structures that are represented in people's mentality (Burgin, 2004).

Thus, the *existential triad* of the world (the world’s global structure) has the following form:

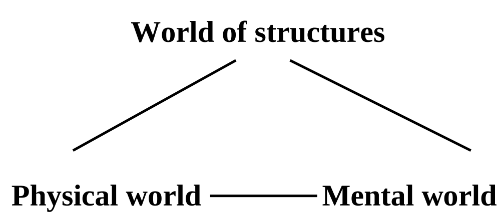

Figure 1. The existential triad of the world

In the mental world, there are real "things" and "phenomena". For example, there exist happiness and pain, smell and color, love and understanding, impressions and images (of stars, tables, chairs and etc.). In the physical world, there are the real tables and chairs, sun, stars, stones, flowers, butterflies, space and time, molecules and atoms, electrons and photons. It has been demonstrated (Burgin, 1997) that the world of structures also exists in reality. For instance, the fundamental triad presented in figure 2 exists in the same way as tables, chairs, trees, and mountains exist. Knowledge, per se, forms a component of the world of structures. It is an important peculiarity of the world (as a whole) that it exists in such a triadic form not as a static entity but as a dynamic structure.

Figure 2. The sign triad of Saussure

It is necessary to understand that these three worlds are not separate realities: they interact and intersect. Thus, individual mentality is based on the brain, which is a material thing. On the other hand, physicists discuss a possibility that mentality influences physical world (cf., for example, (Herbert, 1987)), while our knowledge of the physical world to a great extent depends on interaction between mental and material worlds (cf., for example, (von Baeyer, 2001)).

Even closer ties exist between structural and material worlds. Actually no material thing exists without structure. Even chaos has its chaotic structure. Structures do things what they are. For instance, it is possible to make a table from different material: wood, plastics, iron, aluminum, etc. What all these things have in common is not their material; it is specific peculiarities of their structure. As argue some physicists, physics studies not physical systems as they are but structures of these systems, or physical structures. In some sciences, such as chemistry, and areas of practical activity, such as engineering, structures play a leading role. For instance, the spatial structure of atoms, chemical elements, and molecules determines many properties of these chemical systems. In engineering, structures and structural analysis form even a separate subject (cf., for example, Martin, 1999).

3. Signs, Symbols, and Symbolosphere

If we analyze the usage of the word “symbol,” we come to the conclusion that it has three different, however, connected, meanings. In a broad sense, symbol is the same as sign. For example, the terms “symbolic system” and “sign system” are considered as synonyms, although the first term is used much more often. Another understanding identifies symbol with a physical sign.

However, we are interested in the third meaning of the word “symbol” when it is considered in a strict sense. Such understanding has been developed by Pierce in semiotics as a general theory of signs. It is necessary to remark that the French linguist Ferdinand de Saussure understood "sign" as a category under "symbol." Pierce inversed the words "sign" and "symbol", making "sign" the general word and "symbol" the convention-based sign. The basic property of the sign is that sign points to something different than itself, transcendent to it. This relation is represented by the *dyadic sign triad* introduced by Saussure (see figure 3). Note that this triad is a kind of the fundamental triad.

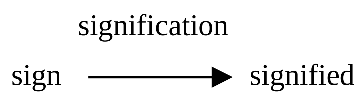

Figure 3. The sign triad of Saussure

This model explicates important properties of sign. However, sign represents something different than itself due to the meaning. That is why Pierce developed this diadic model by further splitting the signified into essentially different parts: the sign's object and interpretant, and thus, coming to the triadic model of a sign, *balanced sign triad*:

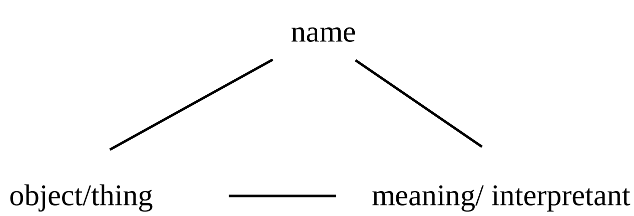

Figure 4. The sign triad of Pierce

This triad is similar to the existential triad of the World with name corresponding to the structural world as a syntactic system, object/thing corresponding to the physical world, and meaning/ interpretant corresponding to the mental world as a semantic system. However, object can be non-material and thus, beyond the physical world.

Nevertheless, object is always closer to the physical world, implying that the Piercean triad is homomorphic to the existential triad, which has holographic properties. It means that all three parts of the existential triad have complete information about the whole triad, which has holographic properties. It means that all three parts of the existential triad have complete information about the whole triad.

A sign is understood as a relation consisting of three elements: Vehicle, Object of the sign and Meaning.

According to Pierce, there are three kinds of signs: *icon*, *index*, and *symbol*.

An *icon* looks like its signified. Photographs at the level of direct resemblance or likeness are therefore heavily iconic. We all are familiar with computer icons, that helped popularize the word, as well as with the pictographs such as are used on "pedestrian crossing" signs. There is no real connection between an object and an icon of it other than the likeness, so the mind is required to see the similarity and associate the two itself. A characteristic of the icon is that by observing it, we can derive information about its signified. The more simplified the image, the less it is possible to learn. No other kind of sign gives that kind of information.

Pierce divides icons further into three kinds. *Images* have the simplest quality, the similarity of aspect. Portraits and computer icons are images. *Diagrams* represent relationships of parts rather than tangible features. Examples of diagrams are algebraic formulae. Finally, *metaphors* possess a similarity of character, representing an object by using a parallelism in some other object. Metaphors are widely used in poetry and language "doe-eyed" and all that.

An *index* has a causal and/or sequential relationship to its signified. A key to understanding indices (or indexes) is the verb "indicate", of which "index" is a substantive. For instance, indices are directly perceivable events that can act as a reference to events that are not directly perceivable, or in other words, they are something visible that indicates something out of sight. You may not see a fire, but you do see the smoke and that indicates to you that a fire is burning. Words "this", “that”, “these”, and “those” like a pointed finger, are also indices. The nature of the index can be unrelated to that of the signified, but the connection here is logical and organic - the two elements are inseparable - and there is little or no participation of the mind. Indices are generally non-deliberate, although arrows are just one example of deliberate ones.

A *symbol* represents something in a completely arbitrary relationship. The connection between signifier and signified depends entirely on the observer, or more exactly, what the observer was taught. Symbols are subjective. Their relation to the signified object is dictated either by social and cultural conventions or by habit. Words are a prime example of signs. Whether as a group of sounds or a group of characters, they are only linked to their signified because we decide they are and because the connection is neither physical nor logical, words change meaning or objects change names as time goes by. Here it all happens in the mind and depends on it.

However, often, especially in science, people try to create words so that they show/explicate connections to the signified. For instance, a computer is called computer because it/he/she computes. A teacher is called teacher because she/he teaches. Some class of elementary particles are called neutrons because they are electrically neutral, i.e., their electrical charge is zero.

Symbols are abstract entities, and whenever we use one, we are only pointing to the idea behind that symbol. Do you know how computer aliases (or shortcuts) work? You create a file that opens the actual file it refers to. If you trash the alias/shortcut, it does not affect the file. Symbols work in exactly the same way in relation to the concept they serve. The $ symbol, astrological symbols, road signs, V of victory, are all symbols.

Pierce divides symbols further into two kinds: a *singular symbol* denotes tangible things, while an *abstract symbol* signifies abstract notions. However, it is not always easy to make a distinction. For example, such symbol as “a dog” signifies an abstract notion of a dog as a specific animal. At the same time, this symbol as “a dog” signifies the set of all dogs. Thus, it is more tangible to introduce one more class of symbols, which we call general symbols. A *general symbol* signifies both an abstract notion and a collection of things encompassed by this notion. For example, “a lover” is a general symbol, while “love” is an abstract symbol.

One and the same word can be used as a name for different symbols and even for different types of symbols. For instance, on the social level, the word a “field” is used as an individual symbol when it denotes a specific place on the Earth. At the same time, it will be an abstract symbol used in mathematical community and denoting a specific mathematical structure, or more exactly, two kinds of structures – fields in algebra, such as the field of all real numbers, and fields in functional analysis, such as a vector field. On another, wider group level, the same word is used as a name of some system, such as a field of mathematics, field of activity or field of competence. Important examples of symbols are general concepts and formal expressions.

Monkeys and apes are capable of what is called indexical communication. These animals have calls that refer directly to things in the physical world, thus indexing objects in the environment. For example, vervet monkeys have calls that index the presence of certain predators. They have specific calls for eagles, snakes, and leopards that unambiguously refer to these animals. However, humans moved from indexical signs to symbols, as they developed language. As they acquired words, these lexical items referred not only to things in the physical world, but also to other words. Frequently, they constituted higher order categories. For example, a hominid might have had specific words for banana, mango, meat, and nut. The development of the word "food" would then refer to all kinds of edible items. In the same way, words for arrowhead, ax, needle, and hammer specifically referred to individual objects that could be subsumed under a more general term "tool." The word "tool" hence referred to the category "tool," to the individual words that named the tools, and to the tools themselves.

Deacon (1997) suggests that when male hominids began to provision food for their mates and their offspring, they may have wanted to be sure that the food they provided actually fed only the children they had sired. The females may also have been concerned that the male provision only her and her offspring, not another woman and her children. Such issues may have led to a union more complex than simple mating, one that could be called marriage. A symbolic relationship sanctioned by the community as a whole would be required for such a social construct, since marriage is strictly a symbolic enterprise. This notion of marriage provides for the emergence of and reference to other terms, such as virgin, in-law, fidelity, adultery. In this way, a web of semiotic relations would grow where, in fact, no material relationship existed. We may say that people are married, but, in fact, they are simply mating in the physical world, and the marriage exists only in the symbolic world.

These considerations lead us to argue that language is not essentially *in* the brain or *of* the brain. Instead, it exists as cultural constructs or artifacts. There are many other artifacts of the same nature. All of them exist and function in social mentality. We call all these artifacts the symbolosphere. The symbolosphere exists through an invisible and nonmaterial technology that functions in our environment and affects our behavior as profoundly as does the biosphere. Language is a part of this system.

4. **Spheres of Life and Existence**

In a complimentary way to the existential triad, the world is stratified into a variety of different spheres, reflecting a variety of world perspectives. The most popular of them is biosphere. From the broadest geophysiological point of view, a *biosphere* is the global ecological system integrating all living beings and their relationships, with their interaction with the elements of the *lithosphere* (rocks), the *hydrosphere* (water), and the *atmosphere* (air). This understanding makes the term "biosphere" completely interchangeable with the term "ecosphere."

Another approach implies that *biosphere* is that part of a planet's terrestrial system - including air, land, water, and living organisms - in which life develops and where living organisms exist. The Earth biosphere is generally believed to have evolved ~3.5B years ago. The biosphere is divided into a number of biomes, inhabited by broadly similar flora and fauna.

The term "biosphere" has geological origin and was coined by the geologist Eduard Suess in 1875. The main development of the concept of biosphere is attributed to Vladimir Vernadsky, who stated that a *biosphere* was a stable, adapting life support system with the potential to be a major geological force on a planet's surface and ecosphere. Under the right conditions, this force could transform the electrical, thermal, chemical and mechanical energy of the universe to meet its own needs.

On a lower level, in comparison with the biosphere, lies the *physiosphere*, which includes such parts as the lithosphere, hydrosphere, and the atmosphere and such phenomena as weather, climate, etc.

A higher level of world is formed by the *sociosphere* considered as the part of a planet's terrestrial system in which social relations develop and where social interaction of people goes on. It includes political and economical systems.

Some researchers introduce an intermediate level between a biosphere and a sociosphere that is called an *ethnosphere*.

On higher levels than sociosphere, such strata as the noosphere, ideosphere, and symbolosphere are situated.

Emergence of the *symbolosphere* is related to the development of language. The first oral or signed languages probably changed form rapidly, leading to a multitude of language systems. Then, about 5,000 years ago, writing developed, essentially as a technology that amplified the oral, nonmaterial, and invisible language component of the symbolosphere. The symbolosphere also includes, of course, mathematics, painting, music, sculpture, and photography, etc. In general, we can define symbolosphere as a component of our world in which symbols emerge, symbolic systems develop, function, and interact and where symbolic interaction of people goes on.

Mathematics gives the most advanced example of a symbolosphere domain as in it symbolism is made explicit, achieving very high levels of abstraction. Formalism is the most extreme approach going in this direction. The main thesis of formalism is that mathematical statements are not about anything material, but are rather to be regarded as meaningless marks. The formalists are interested in the rules that govern how these marks are manipulated. Mathematics, in other words is the manipulation of symbols. The fact that $(a + b) + c = a + (b + c)$ is simply a rule of the system. The principle protagonist of this philosophy was David Hilbert.

However, many mathematicians disputed this approach. For instance, Gödel writes (1961) that the certainty of mathematics is to be secured not by proving certain properties by a projection onto material systems - namely, the manipulation of physical symbols but rather by cultivating (deepening) knowledge of the abstract concepts themselves which lead to the setting up of these mechanical systems, and further by seeking, according to the same procedures, to gain insights into the solvability, and the actual methods for the solution, of all meaningful mathematical problems. Being a Platonist, Gödel represents another extremity in philosophy of mathematics, postulating independent existence of abstract mathematical objects.

In more recent times, electronic technologies have been developed that further amplify the symbolosphere: the telephone, the telegraph, radio, television, fax, the Internet. A storm in the symbolosphere can have the same personal consequences as a storm in physiosphere. This world has a life of its own and cannot be controlled by "operationalizing our definitions," "using language carefully," or attempting to wall off language from "dangerous outside influences." The symbolosphere is subject to manipulation, but all attempts to control it eventually fail.

This realm of our existence must be viewed as part of an ecology that also includes the biological and physical world. Language is but one part of the symbolosphere, and grammar is an even smaller part. In future, we will explore these ideas in detail., radio, television, the fax, satellite-enhanced communication, and most recently, the Internet. All these technologies amplify the symbolosphere and maintain it as an open system in far-from-equilibrium states.

Humans inhabit the symbolosphere as much as the physiosphere and the biosphere. These spheres of human existence are not separate: they intersect and interact. We must know how to deal with the vagaries of the symbolosphere, just as we deal with the vagaries of the physiosphere (i.e., weather, climate, radiation, tornado, typhoons, earthquakes, etc.).

5. The Generic Stratification of the Symbolosphere

The existential triad of the world implies that all full parts and components of the world are structured in the same way as all of them have three constituents: physical, structural, and mental. This shows that the existential triad is a fractal. It means that taking some large-scale sphere of the world, we can find that this sphere has the same structure of the existential triad. Consequently, applying this to the symbolosphere, we obtain three its constituents: physical, structural, and mental symbolosphere. We call this structure the *existential triad of the symbolosphere*.

If we consider some symbol, and corresponding means to see, hear, and/or feel the name of this symbol, we encounter the *physical representation* of this symbol. Symbols on paper and symbols in computer have different material nature but all of them are physical embodiments of mental symbolism and corresponding symbolic structures. According to their essence, symbols exist only inside developed linguistic structures, while each symbol has a definite structure considered in the previous section. This structure is the structural representation of this symbol. Taking a system of symbols, for example, mathematical formulas, we come upon the same situation, that is, these formulas have physical, mental, and structural representation.

Our comprehension forms the mental representation of symbols, which reflects the inherent structure of symbols and their systems.

Nonmaterial strata of the symbolosphere has been developing parallel to its material counterpart. For instance, scientific, or philosophical, instruments, such as telescopes and microscopes, have been used for a long time to obtain and create knowledge by observation and experimentation (Ackerman, 1985). Analytical instruments, such as compass and radar, have been used for a long time for various practical purposes. However, in addition to those two types, analytical and philosophical, humankind in its development created the third type of instruments, namely, a system of intellectual "devices" for dealing with overcomplicated diversities emerged. This system is called science and its "devices" are theories.

When people want to see what they cannot see with their bare eyes, they build and use various magnifying devices. To visualize what is situated very far from them, people use telescopes. To discern very small things, such as microbes or cells of living organisms, people use microscopes. In a similar way, theories are "magnifying devices" for mind (Burgin, 2001). They may be utilized both as microscopes and telescopes. Being very complex these "theoretical devices" have to be used by experts. Theoretical "devices" from the structural and mental parts of the symbolosphere start control and direct physical devices of cognition and practical activity. This reflects a shift of emphasis in the existential triad of the symbolosphere that goes with the development of the human civilization.

However, the existential stratification of the symbolosphere is not unique. Taking into consideration dynamics of symbols, we find a different structure, which is called the *generic stratification* of the symbolosphere (cf. Fig. 5).

Basic Level

is in the

Mental world

↓

Cardinal Level

spans in the

World of structures & Mental world

↓

Comprehensive Level

spans in the

Physical world & World of structures & Mental world

Figure 5. The generic stratification of the symbolosphere

Symbols are conceived as some vague ideas in the Mental World, which becomes the first and basic generic stratum of the symbolosphere. Very often symbols appear in the form of names where names are considered in an extended sense, for instance, a text can be a name.

They become systemic symbols, i.e., related to other sign entities, only being organized and acquiring some structure. This assigns to them their meaning and relates them to this meaning. At the same time, symbols become incorporated into some existing system/structure of symbols and other signs. In such a way, symbols expand to the World of Structures. As a result, the symbolosphere comes into existence on the second generic stratum, which spans into two worlds - the Mental World and World of Structures. We call this stratum the cardinal level of the symbolosphere.

There are two fundamental processes in the cardinal level (second stratum): inner and outer structurization. The first one is an endowment of a symbol with an inner structure, while the second one is integration of the symbol into a diverse net of other symbols. These processes go in the Mental World on three distinct levels: individual, group, and social. The group level has its sublevels. Sometimes results on all three levels, as well as on the group sublevels, are different. For instance, love symbolizes a positive feeling on the social level, a neutral emotion in a group of bureaucrats, and a negative passion for a person (individual level) who was ruined by his/her fatal love.

To become stable and continue to live, symbols have to be embodied, or materialized. There are different ways of materialization: in a static form, as an action, and as a process. Being pronounced, symbols appear in a form of a sound, which is, as we know a process of air vibration. Being drawn or written, symbols acquire a static form. Salutation is an example of an action embodiment of a symbol. In such a way, symbols expand further to the Physical World. As a result, the symbolosphere comes into existence on the third generic stratum, which spans into three worlds - the Mental World, World of Structures, and Physical World. We call this stratum the comprehensive level of the symbolosphere.

For instance, having a notion of quantity (a *mental representation* of qualitative symbols such as numbers) is a long way from the intricate abstract reasoning that today goes by the name of mathematics (Barrow, 1994). Thousands of years passed in the ancient world with comparatively little progress in mathematics.

The reason is that it is insufficient to possess the notion of quantity in a symbolic form. One must develop an efficient method of recording numbers operating with them. Thus, more crucially still, the adaptation of a place value system (a *structural representation* of numbers) with a symbol for zero was a watershed. The aim of structurization is recording numbers and operating with them. A good notation permits an efficient extension to the ideas of fractions and the operations of multiplication and division. However, these discoveries are deep and difficult; almost no one made them (Barrow, 1994). After such notation has been developed, means for recording numbers and operating with them (a *material representation* of numbers) were invented and improved. According to Burton (1997), "the earliest and most immediate technique for visibly expressing the idea of number is tallying (a kind of the *material representation* of numbers, M.B. and J.S.). The idea in tallying is to match the collection to be counted with some easily employed set of objects – in the case of our early forbears, these were fingers, shells, or stones. Sheep, for instance, could be counted by driving them one by one through a narrow passage while dropping a pebble for each."

Another way of counting was maintained by making scratches on stones, by cutting notches in wooden sticks or pieces of bone, or by tying knots in strings of different colors or lengths. However, it was in the more elaborate life of those societies that that rose to power some 6000 years ago in the broad river valleys of the Nile, the Tigris-Euphrates, the Indus, and the Yangtze that special symbols for numbers first appeared (Burton, 1997). To record and operate with numbers, they were written on papyrus, rocks, clay, bark, bamboo, paper, etc.

As symbolic numbering lumbered forward, the invention of a counting tool called abacus, which simplified addition and subtraction of numbers, made life easier for traders, merchants, and others. For a long time, it was the only information processing device for operating with numbers. Later more developed instruments for the same purpose appeared. In the early 1600s, an English clergyman William Oughtred invented the slide rule for dividing and mutiplicating numbers. It was an ancestor of an analog computer. The first ancestor of a digital computer called later Pascaline was produced by the outstanding French mathematician Blaise Pascal around 1642. This was the dawn of the computer era.

A powerful mechanism of the symbolosphere development is a process of metaphoric mapping. Metaphors provide a creative response to cognitive problems, especially valuable for generating new symbols. Through linguistic metaphor, what was impossible, inconceivable, and incoherent based on literal vocabulary becomes possible, conceivable, and coherent.

We can consider introduction of such symbol as a "physical field" as an example of a process of metaphoric mapping. Field in physics began as a convenient representation of action-at-a-distance forces and was later elevated to the status of a physical entity in its own right. The field concept initiated the complete overthrow of Newton's mechanical model of the universe and paved the way for quantum field theory, the mathematical language underpinning contemporary understanding of the universe. Many think that quantum field theory is by far the most accurate and successful model of nature human beings have ever constructed.

At first two physical fields, electric and magnetic, were considered. Such a field is represented by a mathematical construction called a vector field. In mathematics a vector field is a structure in which a vector is associated to every point in some manifold or Euclidean space. In physical fields, these vectors may vary in time.

James Clerk Maxwell, one of the world's greatest physicists, combined the fields of electricity and magnetism and introduced the concept of the electro-magnetic field. For some time, this concept was considered an abstract construction invented to give means for calculation of "real" physical quantities. However, the discovery of electromagnetic waves by the great German physicist Heinrich Hertz in 1888 endowed the status of a physical phenomenon to the electro-magnetic field.

Activity of people involves deeper and deeper immersion into symbolosphere and goes in cycles. Existence of these cycles is explained by the Generalized Poincaré Recurrence Theorem (Burgin, 2004). Scientific cognition, for instance, emerged in works of Aristotle and other Greek philosophers as mostly symbolic activity with only weak ties to physical and social reality. Later the transition to modern science made emphasis on physical phenomena comprehended and evaluated through observation and experiment. However, the development of science in general and any its area has been always characterized by the level of its theoretical component, which always belongs to symbolosphere. Now importance of theories grows completing the cycle of going from symbolic operation to experimentation and back. Many discoveries in physics (e.g., discoveries of electromagnetic field or of positron) were made at first in the corresponding theory and only later validated by experiments. Now such a fundamental system as string theory exists only in the symbolosphere without real experimental evidence.

Analyzing creative processes, we see that at first ideas are conceived in the mind of a researcher. Thus, the beginning of the creative process takes place in the mental world. Then to work on these ideas, the researcher puts then into words. As the great

French mathematician Poincaré wrote (1908), without a name, no object exists either in science or mathematics. To put into words means to ascribe to the idea a linguistic structure. Thus, the continuation of the creative process brings us to the world of structures. Then, after some deliberation, the researcher writes her/his ideas onto paper or, using contemporary technology, puts them into a computer. The result of these procedures is materialization of ideas in the physical world. This explicates the *creative cycle*.

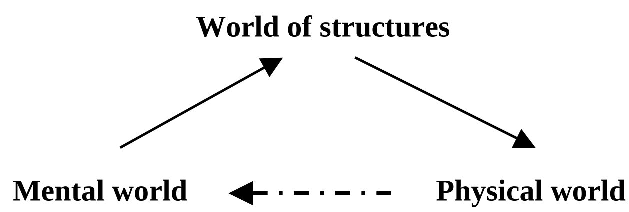

Figure 6. The creative cycle

This is a real cycle because after the ideas become materialized, the creative process continues, repeating the creative cycle. The researcher works with these ideas in her /his mind, developing new ideas, hypotheses, theorems, laws, symbolic models, theories, etc. Then these mental entities acquire linguistic structures and after this are embodied into spoken words, words on paper, and words in a computer.

Even such material activity as engineering acquired its counterpart in the symbolosphere when software engineering came of age. According to the IEEE Standard Computer Dictionary, (1990), software engineering is the application of a systematic, disciplined, quantifiable approach to development, operation, and maintenance of software; that is, the application of engineering to software. Software, at the same time, is a part of the symbolosphere embodied in written texts and states of computer memory. On the other hand (Fairley, 1985), software engineering is the technological and managerial discipline concerned with systematic production and maintenance of software products that are developed and modified on time and within cost estimates. Software engineering covers not only the technical aspects of building software systems, but also management issues, such as directing programming teams, scheduling, and budgeting.

Software development starts in the mental world with decision making what we need the program system to do. The process transits to the world of structures where the problem is broken down into functional blocks - pieces that it is possible to turn into functions or classes in a programming language. The next stage takes the process to the physical world where developed structures of functional blocks are materialized in texts of specifications.

Then the creative cycle is repeated when the software designer starts (in the mental world) an investigation process, trying to figure out what needs to be done and how, in theory, it could be done. The next step brings the design process into the world of structures where the designer determines the functional blocks of the system, determines the details of internal processing for each functional block, and defines their interfaces. In such a way, software architecture is developed.

The software architecture of a program or computing system is the structure or structures of the system, which comprise software elements, the externally visible properties of those elements, and the relationships among them (Bass, *et al*, 2003).

This definition makes clear that *software systems can and do comprise more than one structure* and that no one structure holds the irrefutable claim to being *the* architecture. For example, all non-trivial projects are partitioned into implementation units; these units are given specific responsibilities, and are the basis of work assignments for programming teams. This kind of elements will comprise programs and data that software in other implementation units can call or access, and programs and data that are private. In large projects, implementation units are almost certainly be subdivided for assignment to subteams. This is one kind of structure often used to describe a system. It is a very static structure, in that it focuses on the way the system’s functionality is divided up and assigned to implementation teams.

Other structures are much more focused on the way the elements interact with each other at runtime to carry out the system’s function. Suppose the system is to be built as a set of parallel processes. The set of processes that will exist at runtime, the programs in the various implementation units described previously that are strung together sequentially to form each process, and the synchronization relations among the processes form another kind of structure often used to describe a system.

As Garlan and Shaw (1993) write, “beyond the algorithms and data structures of the computation; designing and specifying the overall system structure emerges as a new kind of problem. Structural issues include gross organization and global control structure; protocols for communication, synchronization, and data access; assignment of functionality to design elements; physical distribution; composition of design elements; scaling and performance; and selection among design alternatives."

A set of architectural elements has a particular form. Perry and Wolf (1992) distinguish between processing elements, data elements, and connecting elements, and this taxonomy by and large persists through most other definitions and approaches.

Besides, the definition implies that *every software system has an architecture* because every system can be shown to be composed of elements and relations among them. In the most trivial case, a system is itself a single element - an uninteresting and probably non-useful architecture, but an architecture nevertheless. This gives additional supportive evidence to objective existence of the world of structures. Even though every system always has an architecture, it does not necessarily follow that the architecture is known to anyone. Moreover, as Buss, Clements, and Kazman (2003) state, an architecture can exist independently of its description or specification, that is, of its embodiment in texts. This raises the importance of architecture documentation and architecture reconstruction.

A complimentary structural representation of a software system is given by algorithms, which are usually designed before a software engineer (a programmer, a team of software engineers/programmers) goes to the first embodiment of these structures in the source code. Physical embodiment of software goes through several stages: writing source code, which contains text in the utilized programming language; compiling, which transforms source code into object code - a translation of the instructions written in the utilized programming language into the native language of the computer; linking all the object code files for the program together to create an executable, and debugging.

Thus, we can see that software engineering exists in the symbolosphere and is realized in a sequence of creative cycles. Many general regularities discovered in software engineering are true in a much more general context. For instance, we can formulate following laws of system science:

Every system has a structure.

Systems, *as a rule*, *can and do comprise more than one structure*.

These laws give additional evidence for existence of the World of structures, as well as for the existential triad of the world and existential stratification of the symbolosphere.

6. Conclusion

The econiche that humans inhabit is both ***physical + structural & mental***. It consists of ***objects + signs & interpretants***. The physical/material world is objective and is the domain of the natural, in particular, physical, sciences. Some scholars would have this domain be the only realm worthy of consideration. This attitude may exist because it is the domain that is most amenable to scientific investigation. It is generally assumed that the nonmaterial realm is by nature relativistic and subjective because traditional scientific technologies have been developed aiming at physical reality. This has been a reason to think that no account can adequately treat the nonmaterial realm. The main point that our account makes is that, as humans, we inhabit both material and nonmaterial worlds, and the latter cannot be dismissed when we find this world complex, conceptually difficult, or experimentally intractable.

References

1. Ackerman, R. *Data, Instruments, and Theory*, Princeton University Press, 1985
2. von Baeyer, H. C. *Information: The New Language of Science*, 2001
3. Barrow, J. D. *Pi in the Sky: Counting, Thinking, and Being*, 1994

4. Bass, L., Clements, P., and Kazman, R. *Software Architecture in Practice* (2nd edition), Addison-Wesley, 2003
5. Burgin, M. *Fundamental Structures of Knowledge and Information*, Ukrainian Academy for Information Sciences, Kiev, 1997 (in Russian)
6. Burgin, M. (2001) How We Know What Technology Can Do, *Communications of the ACM*, v. 44, No. 11, pp. 82-88
7. Burgin, M. (2004) Data, Information, and Knowledge, *Information*, v. 7, No.1, pp. 47-57
8. Burgin, M. (2005) Recurrent Points of Fuzzy Dynamical Systems, *Journal of Dynamical Systems and Geometric Theories*, v. 3, No. 1, pp.1-14
9. Burgin, M. and Milov, Yu. Existential Triad: A Structural Analysis of the Whole, *Totalogy*, 1999, v. 2/3, pp. 387-406 (in Russian)
10. Burton, D.M. *The History of Mathematics*, The McGrow Hill Co., New York, 1997
11. Capuro, R., and Hjorland, B. (2003) The Concept of Information, *Annual Review of Information Science and Technology*, v. 37, Ch. 8, pp. 343-411
12. Deacon, T. W. *The Symbolic Species: The Co-evolution of Language and the Brain.* W.W. Norton, 1997
13. Fairley, R. *Software Engineering Concepts*, McGraw-Hill, New York, 1985
14. Garlan, D. and Shaw, M. An introduction to software architecture, in Advances in Software Engineering and Knowledge Engineering, Vol. I, World Scientific Publishing, 1993, pp. 1-39
15. Gödel, K. *Collected Works*, Volume III (1961) Oxford University Press, 1981.
16. Herbert, N. *Quantum Reality*: *Beyond the New Physics*, Anchor Books, New York, 1987
17. *IEEE Standard Computer Dictionary*, 1990
18. Logan, R. K. and Schumann, J.H. (2005) The Symbolosphere, conceptualization, language, and neo-dualism, *Semiotica*, v. 155, pp. 201-214
19. Keltner, J. W. *Interpersonal Speech-Communication: Elements and Structures*, Wadsworth P.C., Belmont, CA, 1970
20. Martin, W. *Structures: Theory and Analysis*, Palgrave Macmillan, 1999
21. Peirce C. S., *Collected papers*, V. 1-6, Cambridge, 1931-1935

22. Perry, D.E. and Wolf, A.L. (1992) Foundations for the Study of Software Architecture.*ACM Software Engineering Notes*, v. 17, No. 4, pp. 40–52,
23. Poincaré, A. *Scince et Méthode*, Flamarion, 1908
24. Popper K. R *Objective Knowledge: An Evolutionary Approach*, Oxford University Press, Oxford, 1972
25. Popper K. R. Replies to my critics, in *Philosophy of Karl Popper* (Schlipp, P.A., Ed.), Open Court, La Salle, Il., 1974
26. Skagestad, P. (1993) Thinking with machines: Intelligence augmentation, evolutionary epistemology, and semiotics, *Journal of Social and Evolutionary Systems*, v. 16, pp. 157-180
27. Wheeler, A. and Zurek, W.H. (Eds) *Quantum Theory and Measurement*, Princeton University Press, 1983