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SYMBOLISM, ARCHETYPAL MORPHOLOGIES, AND INFORMATION

Originally published as "Symbolizm, morfologie archetypowe i informacja," Studia Semiotyczne 14–15 (1986), 147–164. Translated by Wojciech Wciórka.

1. Elementary catastrophe theory and linguistics

Links between linguistics and the elementary catastrophe theory (ECT) have been mentioned over the course of the analysis of human biological processes from the perspective of the dynamic theory of morphogenesis (Kołwzan 1984). In the present paper, we will draw attention to the origin of language and the relation between ECT and the linguistic issues considered in semiotics (Pelc 1982) and psycholinguistics (Leontiev 1969). We will focus on ways the human brain processes linguistic information, on linguistic units.[1]

1.1. The origin of language

There is a variety of views on the origin of language, both in linguistics and psychology. A discussion on these approaches falls out of the scope of this paper. We will confine ourselves to setting out the account offered by the elementary theory of catastrophes.

According to ECT, the origin of language can be reduced to the general problem of the correlation between language and the external world: the fact that our language provides a relatively adequate picture of the world means that structurally – implicitly – it is a kind of Physics and a kind of Biology. It is *Physics* because the structure of each elementary sentence is isomorphic (isological) to the structure of a broadly understood phenomenological intermittency occurring in spacetime. Furthermore, this structure is

[1] The article elaborates on the idea of qualitative representation of human informational processes presented in (Kołwzan 1984) and (Kołwzan, Święcki 1969).

the bearer of language. On the other hand, our language is *Biology*, because every specific concept is isomorphic to a living thing.

In the case of animals, the functional fields associated with essential biological activities (eating, sleeping. . .) received a mental representation at very early stages, since they significantly affect the image of the body in the subsystem of the nervous system responsible for those activities. Thus we may surmise that several important elements of the animal world acquired a structurally stable image in the nervous system of animals. The *logos* of living things is a universal model for *concept* formation. Stability of these *logos* is, in itself, based on the possibility of regulatory reflexes. Thus mechanisms of regulation are a necessary element in the process of forming those concepts, since each dynamic structure with a high structural stability inevitably contains a corrective intermittence, a catastrophe of regulation. This fact takes place within the qualitative dynamic, and the *logos* of living things must be compatible with this dynamic.

In comparison to animal languages, our language seems to have a double origin. On the one hand, it serves to ritualize a number of functional fields of a genetic origin and, on the other – to notify others about a (new) phenomenon, a danger which might affect the behaviour of an individual or a social group (Thom 1968).

It seems plausible that human language arose for the sake of the second kind of message. Thus it stemmed from the need for informing others about changes in the external environment – about phenomenological 'catastrophes'. Hence the basic structure of a message consists of three elements which make up the so-called Harris's (1962) structure, *SAO*, where: S – subject, A – action (verb), O – object with the direction of action $S \rightarrow O$. At the textual level, A can appear in a neutralized form, that is, it can be symmetric. Yet the real processes always follow the order $S < A < O$.

Thus noun (the *logos* of objects) and verb (the dynamic of a noun[2]) con-

[2]It is the impact range of a noun. It comprises types of relations holding between nouns. According to Thom, the *logos* of a verb is hierarchically higher than the *logos* of a noun. *Logos* of a verb organizes the noun's conflicts. This kind of analysis of the origin of language indicates that the grammatical category as a linguistic concept has a universal linguistic form. So the distinction between noun and verb would also be universal (Thom 1968). We should ask, however, about the nature of other grammatical categories and grammatical rules. We know, for instance, that in many languages *SAO*'s status is very stable, while in others it is not, e.g. in Slavic languages. A problem arises as to which types of information are universal and which are merely local. This bears on constructing a correct grammar of a given language (the grammar of the internal semantic code – cf. below, section 5) not only with a cognitive purpose in

stitute the fundamental archetypes (templates) for linguistic structures which describe spatiotemporal processes. Thom distinguished sixteen fundamental archetypes (Thom 1970: 226–248).

1.2. Symbolism and the origin of signs

René Thom (1973a: 85–106) states that it is customary to regard conceptual thinking, symbol usage, as the crowning achievement of human capacities. Most philosophical systems account for this accomplishment by stipulating a sort of *facultas signatrix* accessible to human beings alone, as opposed to animals. The inventor of ECT takes the opposite stance. The emergence, in the course of evolution, of *rational thinking* within the first men, associated with the use of language, is not as sudden an intermittence as some philosophers tend to think, although the animal–man transition made for a major qualitative transformation. This transformation, however, (probably) amounts not only to a catastrophic innovation in the brain structure but also to a modification of the stages of individual development in view of the presence of a social environment. *Symbolism* must be understood as a certain hierarchical sign structure. One of the most interesting classifications of signs was offered by Peirce. According to him, signs can be divided into:

1) *icons* – i.e. images, which are more or less adequate graphical representations of objects,

2) *indexes* – which are objects or beings connected with the symbolized object and entailed by its existence,

3) *symbols* – this role can be played by any form whose relation to the signified object is a result of a social convention.

Unravelling the secret of human symbolism depends, to a significant extent, on a theoretical account of archetypal forms. These forms serve two important functions: one is the *physical meaning*, the other – the *biological meaning*. Physical meaning consists in the ability to resist the *communication noise*, while the biological meaning can be described as form's ability to produce other forms, important from the biological point of view. Biologically meaningful forms are particularly easy to recognize and are classified within the semantic field of the observer (a human being or an animal). Although the *form of a sign* cannot stray far from its *motivation*, a theory of sign cannot be based simply on the physical meaning of the form of message, since the *meaningful* character of the form is always associated with a certain morphological instability which enables – during a transmission – the creation of a complex of simpler forms. The resulting complex is a *development*, as it

mind but also with a practical one, e.g. that of devising a theory of teaching foreign languages or that of building information search systems.

were, of the initial unstable form.[3] Thus the principal biological imperative of an animal is to recognize prey and predators – hence the higher sensitivity of its sense organs to these typical forms.

The above viewpoint persuades Thom to claim that the main source of symbolism (starting with animals) should be sought in basic regulatory mechanisms of an organism and society. He is inclined to defend the view that the more *neutral* the message, the more amenable it is to imperatives of the physical meaning – the more salient is the structure of the archetypal origin. If the message is *biased*, if it immediately corresponds to an urgent biological or social necessity, then it is morphologically unstable.[4]

Thus a linguistic sign is of a biological origin. It stemmed from the need for preserving an organism in a stable state.

Connections of human symbolism with ECT open up an avenue for research on the semantics of language (morphology of physical and biological meaning). This is tantamount to the possibility of constructing a calculus of forms, i.e. a general semiotics.[5]

2. Information and archetypal forms

Mathematical modelling of fundamental life processes include such mathematical disciplines as *set theory*, *algebraic topology*, *category theory*, *algorithm theory*. In (Kołwzan 1984) we presented several possible methods of employing the above disciplines to construct qualitative mathematical models. Conclusions gleaned from the *mathematical* 'behaviour' of these models can be particularly fruitful for some sciences. However, excessive heterogeneity of these theories could be regarded as their shortcoming.

The aim of the general theory of catastrophes is to find out methods capable of synthesizing these various mathematical models and theories. This will be impossible, however, until mathematicians have solved numerous theoretically and technically difficult problems of a mathematical nature, which underlie ECT. The mathematical theory of semantic information, expressed in the language of geometry, may prove particularly interesting, since the existing mathematical model of the notion of information, offered by information theory, is relatively modest, in the qualitative aspect.

A model of any communication process in the most general form, which

[3]Apparently, this is the way in which a mother tongue develops in a child.

[4]Symptoms of this fact can be observed in syntactical structures (advertisements, poetry, etc.) in which grammatical rules are broken. It also sets up a natural hierarchy of syntactic structures.

[5]For interesting results of applying ECT to the description of natural language semantics, see Wildgen 1992.

takes into account the nature of the transferred information, can be framed as follows:

$$y = T(F(x, r), x, r),$$

where: x – the state vector representing the signal sent by the source, r – noise, $x' = (F(x,\ r)$ – input for the communication channel, composed of the signal and the noise, y – vector signal transferred through the channel to the receiver of the information.

The analytic issue, which arises here, is of great concern. Given a certain y, we want to define – as precisely as possible – the *nature* of x, the distribution of r, the form of $F(x,\ r)$ and the structure of T (Bellman 1961: 289). A similar account has also been adopted by Jumarie (1976: 393–414).

Note, however, that the above formula presents the communication process only from the quantitative perspective, whereas every act of communication involves some *content*. This is why defining the nature of a signal x in the dimension of content is difficult. There is no determinate *combinatorics* (composition) of signals with respect to the contents carried by them. The catastrophe theory only began to conduct research in this direction. This combinatorics, however, is well specified by the mechanisms of the human brain, since each (fairly simple) event in the real world can be described by a human being by means of a finite number of words.

Nevertheless, we would like to have a formal measurement method for the semantic dimension of information. These expectations have not been met by any logico-semantic conception of information theory, albeit each of them assumes that we can speak of semantic information only when we deal with the process of *distinguishing* and *separating* objects. These are the main qualitative attributes of information.

Accordingly, the problem of meaning boils down, in a sense, to distinguishing and identifying objects. Human ability to differentiate and separate out objects formed the basis for *denoting* them. It is worth considering, therefore, what sparked off the emergence of sign,[6] i.e. how it happened that various *forms* became a value *meaningful* to human beings. Furthermore, it immediately leaps to mind that we should consider the possibility of creating qualitatively different – from the existing ones – *methods of measuring meaning*. So what should *the information theory* look like? Thom postulates

[6] In the previous section, we assumed that the emergence of sign was brought about by the need to simulate real phenomena and by the presence of social environment in the life of each individual. It is hard to tell, however – apart from conjectures – what kind of forces lead to the emergence of sign.

that it should be a halfway house between semantics and semiotics, something like the thermodynamics of forms – that it should aim at a rigorously morphological analysis of forms of communication (Thom 1973b; reprinted in 1983a).

At present, the word “information” is used in an ambiguous manner in science. All semantic subtleties of employing this key conceptual category depend on the motivations of its users. Still, we wish that science should be able to establish a way of understanding this term that could satisfy all, or at least most, linguists, since it is the semantic problems associated with this notion that currently take centre stage. Thom puts forward a solution for the problem of information in the light of archetypal morphologies associated with elementary catastrophes (Thom 1973b). On this account, one can provide a general schema (graph) of interaction for a typical situation which we encounter in a process of linguistic communication. It envisages a receiver X of the information, a transmitter Y, a message I, i.e. the information X looks for, and X's action b performed after receiving the information from Y. Thus we have two agents, a question – d, a piece of information – I, and an action – b. This situation can be illustrated with the following geometrical morphology which resembles archetypal morphologies but is more complex – see Figure 1 (cf. Kołwzan, Święcki 1983):

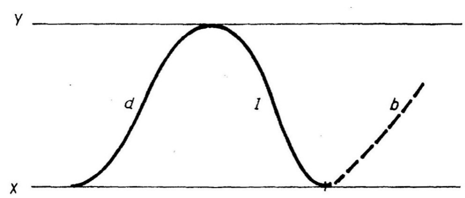

Figure 1: Geometrical schema of information morphology $G = \langle X, Y, d, I \rangle$

Still, this morphology is not an archetype – due to its complexity. It can be analysed into simple, i.e. archetypal, morphologies depending on the character of the *information* (the sense of its use). If the information consists in an answer to a specific question, then the above graph (Figure 1) is reduced to an archetypal morphology, so-called *cut* (Figure 2):[7]

Information can be considered with regard to *transmission*. In this case there is an additional agent – the medium of *transmission*. Such a situation

[7] As an example, consider the legal sense of information usage: X is a judge, d – a question, Y – a witness or a defendant, I – information obtained from Y (forced out of Y), One can interpret a scientific experiment in a similar way, except that, in order to obtain the appropriate information I from the object Y, one must have a suitable measuring apparatus, i.e. a question d (a scientific method).

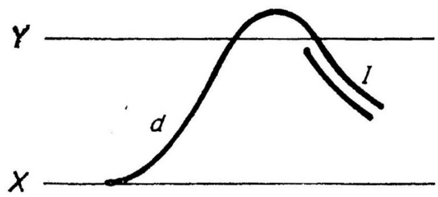

Figure 2: Information as the morphology of *cut.*

is represented by the following morphology of transmission (Figure 3):

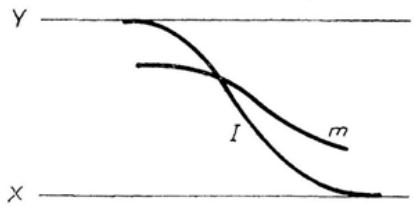

Figure 3: Morphology of *transmission.*

It is, as Thom rightly points out, a situation typical of mass media. It lacks *action* and *question.*

A typical example of *information* can be found in all kinds of advertising techniques. It is a case of open misuse in the sense of information, since it amounts to 'catching' customers. Thus this sort of sense of information can be assigned to the archetypal morphology of *catching* (see: Figure 4).

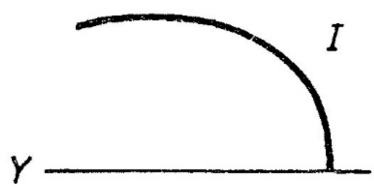

Figure 4: Morphology of *catching.*

One can analyse a lot of other senses of the use of the common word "information."

3. Information in the sense of the Shannon–Weaver model

The aim of the information theory according to the Shannon–Weaver model, is to compare the morphology of the received message with the morphology of the transmitted message. Morphology of transmission is also a typical example of information used in the technical sense. From graph G (Figure 1) we take X, Y, I, and, in addition, we have a transmission channel – m (Figure 3). Accordingly, the term "information" is sometimes improperly used in biology, since here it is understood in a technical sense (cf. Šmalgauzen 1966), while biology deals, in general, with the so-called 'genetic information' contained in DNA. Thus information in the biological sense should be understood as a sort of *agenda*, i.e. a programme of development of a given cell, organ, or a whole organism – rather than a *message*. Multiple theorists of biology, with an eye to applying information theory to their discipline, came to regard any natural morphology as a message which is addressed to the observer and originates from an unknown source. In such an account we may find traces of the old idea according to which *God speaks to us through the phenomena of this world, and it is up to us to decode the language of these phenomena* (Thom 1973b). Such a view raises difficult *ontological* problems. In such a situation one should renounce the notion of sign, since in interpreting this idea one would be forced to admit that each *natural form* is a message from God.

Consequently, the notion of information must involve two ordered pairs: *questioner – answerer* (which conveys the information to the interrogator) and *question – action* (the gain from information). Otherwise, deploying this term (when at least one element is missing) may prove to be of little use. On the other hand, however, the complexity of the graph G (Figure 1) suggests that it is difficult to provide a complete description of all possible realizations of a given piece of information. For that, we would need a complete semantics.

In some cases, the information is conveyed verbally, but in many other cases, e.g. in the case of *genetic information*, the meaningful content is too complex to be expressed verbally. For we are dealing here with a (metabolic or geometric) *form*, of a geometric item which is the organism as a whole. Although the Weaver–Shannon model allows for the assigning of a non-negative number, i.e. the quantum of information, to a message, it does not depend on the *meaningful* content of the message.

4. Information as form

All accounts offered by semantic information theories (Carnap's and Bar Hillel's, Kolmogorov's, Vojšvilla's, Hintikka's, and other) have a common trait, namely, they employ – directly or indirectly (Vojšvilla's theory) – logarithmic probability functions. This convergence of opinion with respect to the role of *probability* function in the transmission of messages allowed Thom to put forward a semantic information theory which regards *information* as a *form* (of an object). Thom pointed out that in each morphology of a linguistic message, as well as in artificial forms, there is always an element of a certain (dynamic) instability. In the case of artificial forms he makes them less probable than in the case of natural morphologies. This yields a probabilistic definition of information. Thus the realization of an event with probability $0 \leqslant p \leqslant 1$ marks the increase of information by:

$$I = -k \cdot log\ p$$

This relation involves deep topological-algebraic correlations regarding the *form* of an event. The point of probability, therefore, is to give us control over a situation of dynamic instability, practical indeterminism. Those who are fascinated by axiomatization of every formal theory see nothing else here but a definition of information in terms of probability. Yet the dependence of information on probability marks a correlation between the singularity of initial conditions of an unstable process and the topological complexity of the output situation. Thus, in fact, we are talking about assigning to this singularity (this improbability) a number specifying the initial instability of information. And so *information is understood here as an object of geometric nature, a nature which brings into relief the complexity of the output state* (Thom 1973b). This yields a fairly precise expression of connections between information and causality.[8]

One might say that the concept of information, in its own right, implies the possibility of *understanding* a certain process (event). This is why one may postulate creating an (semantic) information theory such that the very *act of cognition*, i.e. of understanding a given event, would be a consequence of that theory (Thom 1973a). Accordingly, some believe that the existing formal theories are something external in relation to the material contents of the disciplines to which they are applied, since formulas of these theories are *interpreted* in the framework of those disciplines by means of *added* semantic rules (Bunge 1959: 112).

[8]It can be illustrated with some examples. When the receiver of information X does not yet have access to the desired information, her mental state can be compared to the following situation: if we put a pencil on its head, we can say that this position on a plane *encodes* a circle with a centre at O and a radius equal to the length of the pencil. Each point of the circumference corresponds to one of the stable output situations which can take place in this initially unstable situation. The same happens to the mind of information-receiver. After obtaining the desired information, the mental state moves from an unstable situation to a steady one (locally, since it might be in need of some further information; the receiver's mental state shifts from an unstable local maximum to a stable local minimum).

The force of the form of objects is particularly salient in human thought and language. The structure of human symbolism is shaped by the existence of *physical, biological*, and very tenuous *symbolic* (sign-) *forms*

5. Information theory and semiotics

The classical Shannon–Weaver information theory as well as logico-semantic theories of information are examples of algorithmic theories. In particular, the former theory allows us to calculate the complexity of a system, that is, the degree to which it diverges from the state of total chaos. Such an algorithm can be provided for one-dimensional structures, i.e. for signal sequences. Yet, in addition, we would like to have an algorithm for composing multidimensional structures. Relatively simple processes, whose dynamic can be replaced with verbs, can be characterized by means of archetypal forms. This paves the way to a qualitative investigation into the phenomenon of information. Algorithmic representation of compound processes involving a number of structural elements greater than four, or of *nongradient* processes (in the mathematical sense), is almost impossible. For there is no general catastrophe theory; and so we do not know an algorithm for algebraic composition of multidimensional forms. In other words, there is no *calculus of forms*. Still, our analysis of the term "information" encourages us to consider an analysis of the notion of the *communicational situation* of a human being, which is represented by a natural language.

Language, as a system of signs, should somehow represent the semantic content of processes in the form of semiotic syntactic structures. Of course, such a representation should have a *functional* expression. It should preserve the structure of the represented process, and the semiotic syntactic structures should be construed in the same way, regardless of the particular natural languages. A question arises, therefore, about the connections between the semantic content of a message and its semiotic structure. In order to answer it, one must appeal to the origin and structure of the human symbolism. All this, in turn, is required if we intend to put forward a hypothetical schema of information-processing by the human brain.

As we have already mentioned, Peirce distinguishes – in the structure of human symbolism – icons, indexes, and symbols (arbitrary signs). The division is very adequate and methodologically fertile. Thom (1973a) associated each group of signs with a suitable space: icons with the physical space, indexes with the biological space, and symbols – with the semantic space.

The core of this correspondence is simple.[9] It is enough to notice that in

[9]The simplicity, as Sebeok (1976) points out, stems from the fact that both Peirce and Thom are gifted with rich imagination and represent a similar style of thinking.

the physical world we encounter only icons (e.g. an image of a tree in water), in the living world – we deal with indexes, and in the world of symbols – and only there – with conventional signs as well. These spaces are structurally stable and are marked by hierarchical correlations. Such an account suggests that the development of symbolic signs went from (physically) simple signs to more complex ones.[10] It was also accompanied by the emergence of ways of informing and information processing. Thus it gave rise to three distinct *qualitative* types of *information*.

This perspective, in turn, entails the necessity of a closer analysis of the structure of human language. It can be characterized as a three-level symbolic system (a stratificational model): physical space corresponds to the phonetic level, biological space – to the syntactic level, and semantic space – to the semantic level. Each level, in turn, consists of the paradigmatic plane (units of a given level together with differentiating opposite properties) and the syntagmatic plane (rules for combining units into higher-level units) (Kołwzan, Święcki 1983). By virtue of these planes, each element of a given level can be analysed into units, which are elements of a lower level.

Units of the semantic level are Thom's archetypes, whose interrelations constitute the internal semantic code (ISC) of a human being. It can be assumed that these archetypes make up the paradigmatic plane of this level of language, while the syntagmatic plane would amount to the postulated *calculus of forms*.

Archetypal morphologies are divided into at most four agents – expressed by suitable syntactic forms (surface structures); otherwise a given syntactic form must be analysed in several forms, each containing a number of agents which satisfies the requirement of complexity of particular archetypes. Units of the phonetic level are phonemes constituting speech.

At this point, we would need a good external *representation* of ISC, semiotically understood, interpreted in the same way in any language. Thus it is tempting to specify conditions which must be fulfilled by a semiotic representation of ISC, which simulates materially (with respect to content)

[10] In more recent works, Thom elaborates on the issue of the origin of signs, their connection with space, and the genesis of language. He admits, however, that these discussions are speculative in character, especially with respect to the origin of language (Thom 1983b). Thom's position also shifted with regard to the account of meaning formation. The physically meaningful form and the biologically meaningful form have been modified. He introduces the notion of *salient form* (*la forme saillante*), which is distinguishable against a given *background* (*le fond*). Such salient forms can acquire a physical or biological meaning, which mark *being pregnant* (*la pregnance*) with consequences stemming from the existence of *saillance* (Thom 1980, 1982).

concrete, spatiotemporal *macrosituations*. It should be independent from the phonic matter of the users of a given natural language. Thus it should be a record of the *pure sense*.

We can assume that each human being perceives the world in a homogeneous way. Then the semiotic record of a given piece of information should be equally understood by a given human being regardless of the language she speaks. It should contain the list of archetypal morphologies, the agent structure of these morphologies, and the rules of composition corresponding to the calculus of forms obtaining in the ISC.

Among all the attempts to invent such a code, the most promising one is the theory of universal semantic code (USC) put forward by Martynov (1974, 1977). The central idea of this account is quite simple. The starting-point is the string analysis of natural-language messages, initiated by Harris (1962). It consists of examining the possibilities of a natural extension of a simple semiotic string SAO. Such an analysis allows us to establish two possible ways of expanding the string SAO: (i) by adding 'second' subjects and objects: $S_1S_2AO_2O_1$– S_1 by means of the instrument S_2delivers the object O_2 to the object O_1; (ii) by adding SA to the left side of SAO: $S_1A_1S_2A_2O_1$ – S_1 makes S_2 act on O_1.[11]

The list of archetypes has been translated into semiotic strings representing USC. This translation will not be repeated here (see Kołwzan, Święcki 1983), yet, for the sake of illustration, let us give an example from the list of translations: morphology of transmission corresponds to the semiotic structure $S_1S_2AO_2O_1$, where:

$$S_1 = Y,\ S_2 = m,\ O_1 = X,\ and\ O_2 = I$$

6. The notion of natural semiotic triangle

Although we have not quoted the full list of archetypal forms into corresponding semiotic strings, it is necessary to explain what this translation amounts to. In order to do so, one must first invoke some specific results, obtained during the course of considering issues connected with semantic information and information processing by the human brain. The list of translations is based, in a nutshell, on the opposition between continuity (archetypes) and discreteness (semiotic strings) and amounts to comparing the number of agents which take part in a given process. But what was the motivation for selecting this simple principle as the basis for translation?

[11] Optional dashes over S_1,S_2, O_1,or O_2 mean that a given agent does not play an active role in the action, e.g. $\bar{S}_1S_2AO_1$ means that the instrument S_2 was used to act on O_1. S_1 is an indefinite subject of the action.

Research conducted by Rashevsky in the field of mathematical and general biology allowed him to formulate a postulate, important for biology as a whole, that *each organism in its own right is a system of mappings*, and to prove that each organism involves mappings of the many-to-one type. This type of mapping is instantiated by so-called *biological epimorphism* (Rashevsky 1960).

Does this mathematically expressed principle have an experimental justification with respect to information processing by the human brain? The point is that neurobiologists are in agreement as to the difference between animal and human brain structures. It amounts to the asymmetry between the left and right hemisphere of the human brain (Ivanov 1978). Anatomically, this asymmetry manifests itself in the domination of one hemisphere over the other. The brain of an animal is almost perfectly symmetric in this regard.[12]

Experimental data allowed us to provide a division of functions of both hemispheres. It has been established, inter alia, that the right hemisphere is responsible for continuous processes. It maps images of a concrete nature – *here and now* – and is responsible for spatiotemporal orientation. Generally speaking, it is a geometrical hemisphere. By contrast, the left hemisphere is responsible for discrete properties, logical functions (*yes* and *no*), operates on abstract mental images. Its injury tends to result in speech disorders. It is a typically algebraic hemisphere. Thus it contains innate generative mechanisms, which are responsible, especially in children, for the development of grammar of the mother tongue.[13]

We can infer from the above data that the human brain has access to the rules for translating archetypal forms into discrete ones, and vice versa, since one of the characteristic features of human language (mind) is that a human being is capable of reproducing (simulating) meaningful forms which are spatially and temporally distant.

The phenomenon of cerebral asymmetry suggests that the arbitrary sign is also analysable in the right-hemisphere part, i.e. *signifié*, and the left-hemisphere part, *signifiant*. However, as shown by respective research, human beings do not inherit concrete contents, so it becomes fairly clear

[12]It has been proved experimentally that severing the corpus callosum connecting human cerebral hemispheres brings about the existence of, as it were, two independent brains; which has not been observed in animals.

[13]It should come as no surprise, therefore, that Chomsky endorsed the conception of innate ideas (Chomsky 1965). One may cast doubt on many arguments put forward by Chomsky and the advocates of his generative-transformational theory of language. One of the most plausible critiques of Chomsky's theory has been mounted by Pazuchin (1977). Yet there is no denying that the theory is scientifically reasonable.

why the highest sign in the hierarchy of symbolism is arbitrary in character. On the other hand, the fact that it belongs to the right hemisphere confirms Thom's hypothesis that no sign-form can stray far from the motivation which brought about its usage. This motivation can be reduced, in general terms, to the necessity of existence of the *signifié* part of the sign, which in turn is closely associated with the spatiotemporal position of the referent, representing its physical, biological, or symbolic form (Thom 1973a).[14] And so the arbitrariness of a sign is limited. Otherwise, we would deal with an infinite number of archetypal morphologies and an infinite number of signs. In such a situation communication would be hopelessly complicated.

The requirement of a finite number of archetypes is an important indication that both the set of macrosituations and the sign structure of language should contain certain types of relation. They have been pinpointed in the

[14] We can also speak of right- and left-hemisphere information. Due to the abstract (algebraic) nature of the left hemisphere it was possible to set out formal theories, especially a quantitative information theory and logico-semantic information theory. Yet they are unable to fully evaluate the content of messages. In these frameworks, *subjects* represent the conceptual category of *noun*, *predicates* – of *verb*. Neuropsychological data help explain why giving a complete picture of the structure of natural language within logical accounts is impossible. Logical constructions of natural languages presuppose that each natural language can be reduced to a *logical language*, in which we distinguish *n* subjects, predicates, and introduce logical operators. Statements are assigned a truth-value (truth, falsity, or some other value depending on the assumed model of logical theory) and are accompanied by *rules* for deriving true statements (operators of logical consequences). In addition, there is a distinguished set of true statements, called the *set of axioms*.

At the same time, it is assumed that the logical description of natural language can express its syntactic structures (logically extremely complicated) but that *semantic rules* are unknown. Thus the description cannot be complete, since semantics of natural language should be associated not only with the left hemisphere but also with the right one, which is responsible for the *shape* (form) of objects. The right hemisphere can embrace rules for composing semantic units representing the continuous aspect of the world – either internal (concepts) or external (processes, macrosituations). The continuous world cannot be enumerated, since its objects are not sharply separated, their boundaries overlap each other (Thom 1972: 68–82). This is the reason why it is difficult to unambiguously assign objects to linguistic signs. Sets of objects are not divided into *classes, of abstraction*. Rather, they form classes defined by the relation of tolerance, which in the case of human beings, as suggested by Zeeman (1965: 277–292), is an innate relation. It should have its place in the semantic information theory. In terms of this relation, it is much easier to account for the process of forgetting (in humans) than by means of so-called *information* (*bit*) *loss*. If events are reflexive and symmetric, then what is earlier merges with what is later (Zeeman, Buneman 1970: 134-144).

framework of systems theory. In the course of exploring general aspects of the organization of matter, it has been observed that certain forms of system organization are invariable. They recur in various phenomena and processes. It is, as it were, a constant (stable) attribute of matter. Similarly to what Rosen and Rashevsky did in the case of laws of biology, we can speak of the need to examine similarities between connections, organization, etc. of objects – rather than investigating the particular (singular) objects themselves. In reference to natural systems, such as language, two kinds of relation have been distinguished – *systemic* and *linear*. The distinction stems from the fact that the human mind has the property of, so to speak, resonating – coordinating the behaviour of its own subsystems with functions connecting its own behaviour with behaviours of other systems, e.g. receiving and understanding external stimuli by adapting the behaviour of its own subsystems.

A set which consists of subsystems is called a *collective* (Martynov 1974: 91 and *passim*). Such sets are formed by virtue of the contact of their elements (e.g. an arm is in contact with a shoulder joint). So they are defined by the relation of symmetry. The relation of contact is called a *linear* relation or a *collision*. In addition, we distinguish sets formed by virtue of resemblance, i.e. the *relation of tolerance*. These relations are dubbed *systemic*. A division of a system into subsystems according to a linear relation yields a set of subsystems which lacks some properties of a given natural system, e.g. if we divide a table into legs, top, and other parts, we will only get a set of elements whose function in the system 'table' is different from their function in the collective set. By contrast, the resemblance relation preserves all properties of the system: the division into *functional systems* is a systemic division(respiratory system and others). Each system is relatively autonomous and can function 'separately'. It is not possible to replace systemic relations with linear ones. They are complementary.

In language, they are represented by planes – *paradigmatic* and *syntagmatic*. Thanks to these two planes, there are statements of an identical syntactic form but of a different content:

$$\begin{pmatrix} \textit{A child} \\ \textit{A doll} \end{pmatrix} \begin{pmatrix} \textit{sits} \\ \textit{stands} \end{pmatrix} \begin{pmatrix} \textit{in} \\ \textit{on} \end{pmatrix} \begin{pmatrix} \textit{the chair} \\ \textit{the table} \end{pmatrix}$$

Elements in brackets stand in paradigmatic relations, while combinations such as ...... *sits in*...... – in syntagmatic relations.

In the general systems theory, information is defined as the environmental influence, which elicits a suitable reaction from the corresponding system. Energomatter amounts to powering a system, which is not a very precise notion (Laszlo 1975).[15] Święcki (1981) understands information as the environmental influence on the system's systemic relations and energomatter – as the environmental impact on its linear relations. This is in accordance with Thom's idea, according to which information is a geometrical form reflecting the mutual influence of natural systems, i.e. the *logos* of the whole structure.

It turns out that this division corresponds to the distinction between the right- and left-hemisphere perception of the world. However, the right-hemisphere way of perceiving the world is more closely related to the phenomenon of information in the aspect of content, while the left-hemisphere world-view is closer to representation of the information, so the left hemisphere has a stronger connection to language. On the semiotic plane it can be USC, while ISC represents the content of USC-strings, i.e. information.

Thus we have arrived at the connection between the language of information and the sign, that is, to the classical notion of the semiotic triangle, introduced by Ogden and Richards (1923) and others. Figure 5 presents the graphical form of this triangle.

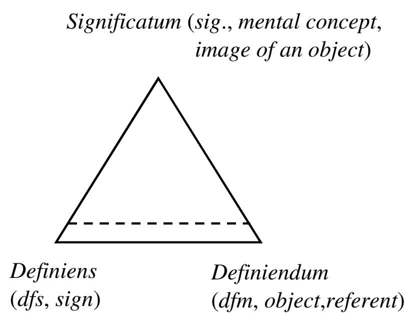

Figure 5: The semiotic triangle

[15]Cf. e.g. Miller's (1969) view on energomatter.

Sig. refers to *dfm*, while *dfs* symbolizes and denotes (represents or stands for) *dfm*. The broken line between *dfs* and *dfm* marks the arbitrariness of a sign.

Semiotic triangles appear in science in various versions. Yet, in fact, they express the same idea. They connect the human mind with the external world R_1 via a sign, i.e. the world R_2 (Martynov 1978: 223).[16]

The triangular diagram has been undermined by Mel'nikov (1988). He observed that, in addition to the mental image of an object, there must also be a mental image of a sign. Such a schema of information processing is directly linked to the division of the brain into the right hemisphere (the image of the referent) and the left one (the image of the sign). Furthermore, both kinds of image have three levels, both in the case of perception of the external world R_1 and of the world of signs, R_2 (see Figure 7). The schema of information processing by the human brain, according to Mel'nikov, should be represented by a pentagon instead of a triangle – see Figure 6:

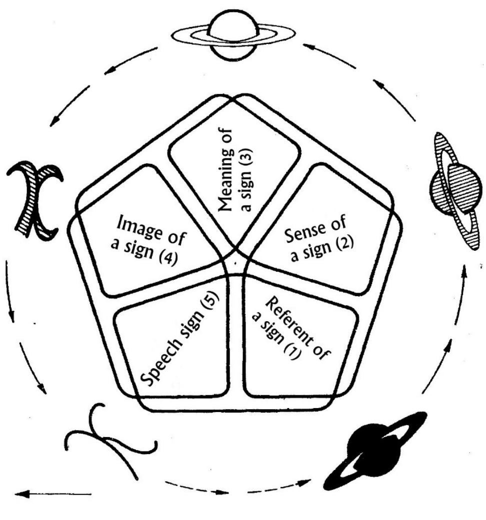

Figure 6: Pentagonal diagram of human information processing.

[16]Note that semiotic triangles emerged over the course of formal considerations about natural language and the language of logic, thus they should be transformed into a natural form, corresponding to scientific knowledge regarding the ways of information processing by the human brain. Apart from semiotic triangles, there is also a semiotic square, introduced by Greimas (1987). Petitot (1983) and Thom (1983c) analysed this square in the light of ECT.

Legend:

- 1–5 – levels of information processing
- unbroken arrows – the direction of information processing
- broken arrows – means that there is an arbitrary relation between the sign and the referent

From the perspective of linguistic communication, particular levels of Figure 6 should be interpreted in the following way:

1. the level of referents– physical carriers, non-communicational units;
2. the level of senses – refers to the sense of usage of a given unit; these are both concrete thought-units, e.g. a running man, and imagined or abstract thought-units, e.g. generalized image of a running man;
3. the level of meanings of signs – mental (psychological) communicational linguistic units;
4. the level of images of signs (morphems) – these are communicational images of meaningful units, e.g. an image of the word *cat*;
5. the level of speech signs – physical communicational units of speech, concrete messages.

The diagram in Figure 7 shows that particular levels are connected with each other in the following way: (1)–(2), (2)–(3), (3)–(4), (4)–(5), and (1)–(5).

Mel'nikov's critical remarks about the semiotic triangle allowed Święcki to introduce the notion of a natural semiotic triangle (Święcki 1981) – see Figure 7:

The natural semiotic triangle illustrates the transformation of continuous processes into a discrete sign form.

Conclusion

Admittedly, the present attempt at a qualitative analysis of human informational processes is marked, in many places, by excessive liberty of judgements. Nevertheless, it seems that the issue of qualitative analysis of these scientifically significant processes grows increasingly important. Thus it is worth analysing in a more conceptual, as opposed to formal, fashion. In fact, attempts at conceptual analysis have already been made before (Schank

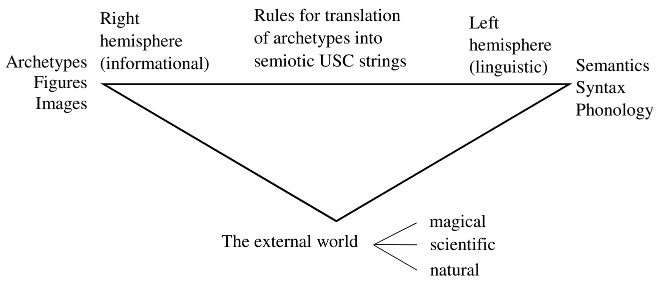

Figure 7: The natural semiotic triangle.

1975). This kind of analysis not only brings practical scientific benefits, which are exploited in the Artificial Intelligence project, but also contributes to science in purely cognitive and philosophical terms.

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