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THE MECHANICS OF SEMIOTICS AND OF THE "HUMAN MIND"

Part II

In the second part of my paper (part I published in Semiosis 15) a discussion of the information stored in the human body will be touched upon before an attempt is made to explain how semiotic elements (in their communicative aspects) function when used for information retrival, information processing, and therefore most probably analogous to the processes in the human mind.

The following quotation from Peirce give reason to think that the idea of using signs of objects as 'pointers' to signs is not new.

The philosophy of pragmatics was defined by Peirce (Popular Science Monthly, - 1878) so: *"Consider what effects, that might conceivably have practical bearings we conceive the object of our conception to have. Then our conception of these effects is the whole of our conception of the object."*
That statement although a meta-theorem expresses the basic idea of the relationship between pragmatics, and semiotics as does the following statement by Peirce: *"The next moment of the argument for pragmatics is the view that every thought is a sign."* (CP 5.11-13, pp. 274).

1. "PERMANENT" INFORMATION

Despite the advance of sciences, or just because of it, today's technology is faced with problems of increasing complexity. In the living things the problems of organized complexity has been comprehended to a certain degree, which led to some spectacular achievements. It is natural, therefore, that an increasing circle of the sciences look to nature's inventions for clues for new classes of man-made machines with greatly increased capabilities. An infant science is born now almost every year like the one announced at a symposium recently called sociobiology (7) or the one that resulted when biology and electronics mixed in bionics in order to study living creatures in hope of gaining knowledge to improve man-made mechanisms.

Genetics is perhaps the most significant of all young sciences which promises acroamatic comprehension of the anatomical organization of the human brain, its functions as well as its organs and elements.

It is well known, that the laws of heredity possess almost mathematical simplicity indicating that we are dealing here with one of the fundamental phenomena of life.

A grown-up person is made of about 10^{14} cells, each cell containing some 48 chromosomes. It is known, that the volume of a chromosome is approximately 10^{-14} cu.cm. It is a well established fact, that one chromosome is responsible for as many as several thousand different hereditary properties. Dividing the total volume of the chromosome by the number of separate genes it is found, that the volume of one gene is $\geq 10^{-17}$ cu. cm. Since the volume of an average atom is about 10^{-23} cu. cm. [$\cong (2.10^{-8})^3$] it is established that each separate gene must be built from about 10^6 atoms which is well into the order of a molecule.

Thus, it seems that in the gene science one has found the missing link between organic and inorganic matter. Considering on the one hand the remarkable permanence of genes which carry almost without any deviation the properties of a given species through thousands of generations, and on the other hand the comparatively small number of individual atoms that form one gene one can not consider it otherwise than as a well-planned structure in which each atom or atomic group sits in its predetermined place.

The difference between the properties of various genes which are reflected in the external variations among resulting organisms, the characteristics of which they determine can then be understood as due to variations in the distribution of the atoms within the structure of the genes.

Considering the gene as one giant molecule built from 10^6 atoms arranged as a long chain of repeating atomic groups with various other groups attached to it (at different points) like pendants as in organic chemistry; a speculative assumption, for example, would be a case of 25 pendants, 5 of each different kind where the number of possible distributions is some $6{,}233.10^{10}$. Isomeric transformations are blamed for mutations yet, this subject as well as the related topics such as the evolution of species is beyond the scope of this work. The information contained in the genes of each cell, thus lies the key to all present, past and, future human shapes, structures, and organs.

Physiologically and hystologically there is little apparent difference between human brains ("The Self and Its Brain", K. Popper & J. Eccles). Yet, human brains are as different as human faces or finger-prints. Genetically as well as psychologically there is no such thing as morphology in human brains, i.e. there are as much different (anatomically structured) human brains as there are human beings.

The store of information in the chromosomes is a direct result of the human evolution, and an indirect result of the culture attained in the course of generations. This intrinsic memory is practically nondestructive and has a capacity of thousands of millions of megabits. These are instructions around which the human body builds and shapes itself, according to these instructions the brain tissue arranges itself into its isomorphical web and according to these same instructions the future generations will be shaped.

Recognition and perception are possible via channels already given within (8) the brain. Information storing would be quite impossible without prearranged interconnection and signals. Prime reflexes and instincts could be looked upon as nondestructive information given 'a priori'. It is a fact, that this acromatic web of nondestructive information (9) in some cases is the cause for imbecility, or at least is the cause for poverty of intellect. However, if this is so, then the other extreme should hold true, i.e. a genius then, would be a direct result of genetic heredity.

The activity of the chromosomes, whatever it may be, must be considered as a set of (stored) signals.*

The life history of the organism is regulated by the interactions of the various parts of the organism which is living in an environment subject to a considerable amount of random fluctuation. Yet, in spite of general disintegrating processes of the physical world, and the random fluctuation of the environment, large organisms with structures built according to a detailed plan must be kept running according to a program during the life cycle. The amount of information involved is incredible, and runs in the millions of megabits, where part of that information most probably was acquired during a life cycle.

The large amount of characteristic detail in the organism is the equivalent of a large amount of signal detail in communication theory. Equivalent of retaining all the characteristic individual detail despite the presence of the fluctuating environment, is the maintenance of a large signal to noise ration which is usually obtained by repetition of the signal according to some predetermined plan. It is, therefore, not surprising to find that in the case of large organisms, the fundamental information contained in the

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* A large improvement in 'signal-to-noise' ratio in frequency modulation is obtained by repetition of the signal in the frequency domain.

structure or activity of the chromosomes which regulate the life history of the organism is arranged so, that the information is repeated coherently, i.e. according to a programmed layout. Thus, the division of the organism into cells, each of which has an essentially identical set of chromosomes is a way in which nature can keep a large organism operating in a programmed life cycle despite the disintegrating effects of the physical world.

It would not be too surprising if the proper theoretical tool for approaching this problem turned out to be communication theory. So far the (10) application of communication theory to visual perception has mainly been in the earlier steps along the visual pathway. For example, two theorems of information processing - the sampling theorem and Logan's zero crossing theorem - are being invoked to explain how information sent along a limited channel, such as the optic nerve, can in principle be expressed in more detail in the visual cortex of the brain. In addition David Marr (11) of the Massachusetts Institute of Technology has sketched some of the kinds of computation the brain must perform in order for us to see things as we do. This has made us realize the complex nature of the problems involved.

Our capacity for deceiving ourselves about the operation of our brain is almost limitless, mainly because what we can report is (12) only a minute fraction of what goes on in our head. This is why much of philosphy has been barren for more than 2000 years and is likely to remain so until philosophers learn to understand the language of information processing.

This is not to say, however, that the study of our mental processes by introspection should be totally abandoned, as the behaviorists have tried to do. To do so would be to discard one of the most significant attributes of what we are trying to study. The fact remains that the evidence of introspection should never be accepted at face value. It should be explained in terms other than just its own.

A mathematical definition of information in terms of entropy or choice is used by Shannon and others. This definition of information applies to average conditions in an ergodic* sequence without specifying the information associated with individual messages. This is the noiseless case, the entropy of a

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* An ergodic system of symbols is one in which the occurrence of symbols is controlled by probability but no appreciable intersymbol influence extends over more than a number of symbols whose top value is finite.

long sample of 'n' symbols duration of an ergodic sequence is determined in the form:

$$H = H\ (x1,\ x2,\ x3,\ \ldots,\ xn)$$

and the rate R of the transmission of information is taken to be:

$$\dot{R} = \frac{H}{T}$$

where T is the time duration of the 'n' symbols.

In order to be ergodic for a system of symbols, it may be shown that the intersymbol influence must ultimately fall off at at least an exponential rate. An ergodic sequence in which there is no intersymbol influence may be called a pure random sequence, and the process which generates it may be called a pure random process. The term 'ergodic range' is used for the range of the intersymbol influence in an ergodic system.

As it will be shown later in this chapter, the human brain is apparently accustomed to deal fully with only relatively short (12) sequences at one time and cannot take full advantage of the language transmission capacities of systems for long sequences*. In information theory, there are two perspectives which can be used as tools for expressing the functions of the human mind. First, *entropy* and *choice*, and secondly, *probability*. If the second perspective is taken, i.e. probability in information theory (log base 2) so:

$$\text{information received} = \log \frac{\text{probability at the receiver of the event after the message is received}}{\text{probability at the receiver of the event before the message is received}} = \log \left(\frac{P'}{P}\right);$$

as the fundamental definition of the information transmitted to a receiver by a message. In the "noiseless" case, i.e. the case in which the probability after the message is received (p') is unity, the equation is reduced to:

$$\text{information received} = -\log p$$

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* It should also be remembered that long sequences, if fully utilized and not protected by planned redundancy, are very succeptible to great harm by small amounts of noise. This is undoubtedly part of the reason why long sequences are not fully utilized in human communication systems (EB).

With the definition of information given above each individual message transmits an amount of information to the receiver which depends upon the probability of the event which it describes: and in the case the message is erroneous, the amount of information transmitted may actually be negative.

So it becomes quite obvious that in conscious processes of the mind the first perspective, namely that of entropy and choice have to be used. Any dedicated thought is a purposefull conception, not a random process. However, there is much in resemblance between these methodes of communication, and because such terms as 'source', 'sink', 'feed-back', and 'channel' are common within the framework of information theory, these shall be used in addition to those mentioned in connection with semiotics, and calculus of trees.

A physical illustration of the hypothesis of triadic, functional, signrelationship, i.e. semiotic information processing scheme can be readily found in the origin of the genes, chromosomes, and cells. Only when a set of chemical reactions closes on to itself (fulfilled semioses) are the cells ready to divide and information transfer is complete.

2. MECHANICS OF SEMIOTIC INFORMATION PROCESSING

In an encounter between Noam Chomsky and David Premak*, Chomsky, who is professor at the department of linguistics and philosophy at MIT said: *"Do humans or other creatures spontaneously use mentally represented or physical symbols to encode experience, carry out though and perform perceptual judgements? We probably agree on what we expect to find. Symbolic representation in this sense is not specifically human, by no means specific to human language"*. That implies that symbolic representation, indexes, and pointers are inherent in information as such, and also in information processing. Further Chomsky: *"I think a fair amount is known about that. It involves a finite system of recursive rules of computation with very non-trivial properties that allow, for example, for infinite naming with embedded propositional content, and so on"*.

If structures and networks are the basics of information processing, then semiotics can be seen as basics for structures and networks. With that we are back at the mechanics involved in the communicative aspects of the semiotical representational schemes.

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* That discussion appeared in "The Sciences", November 1979.

At the present time semiotics are employed as pure, as well as applied sciences (13). Therefore, some times the theoretical, and some times the pragmatical aspects are in discussion, however, this should not mislead to an interpretation of semiotics as being a deductive theory, which holds true for certain parts of mathematics (number theory, algebra), and theoretical mechanics, but becomes quite doubtfull in the realm of logic as shown by F. Weismann (in opposition to Russell and Whitehead (13)).

In its present form semiotics is rather part of an abstracting theory, of empirical origin, which basics are reconstructable, consolidated, and of limitless operationality.

Because of the fact that semiotics is a thoroughly thetical (designated), and not a given reference system it is determined accordingly, i.e. in the sense of its existing, and ready functionally operating thetical parts.

Both, the sign as well as information per se, do not occur in nature, and are not subjects of the natural sciences. Nevertheless, communication of information (in general sense) requires energetic or material signs, and their carriers which combined result in signals, and signal functions. However, this is not the subject of discussion because not a 'physical' channel is investigated, but one of 'software' in which information 'flows' and without it no information processing can take place. In other words, a third kind of an element next to matter and mind will be the 'container' of information. Nevertheless all the aspects and phenomena of information theory have counterparts in the natural sciences*.

Only in respect to its threefold (substitutional) functions of representation, communication and foundation schemes is a sign a "tool" and semiotics an "organon" in Wittgenstein's sense (Max Bense). That is to say, we have here not a deductive but an operational theory and its theoremes are not only rules for intellectual handling, but are methodic constructive, executable functions in action. The thetical introduction of signs in this respect is just such an intelligent manipulation as is the selection of a presemiotically set repertoire. Producing the relationship between designated object and interpretant as context or connex out of the same repertoire for instance is just such an intelligent manipulation.

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* In this connection see 'Essays' on the Use of 'Information theory in biology', edited by Henry Quastler, University of Illinois Press, Urbana, Ill., 1953.

As all operational theories so semiotics is a pragmatic one. As Peirce already formulated, all pragmatically oriented theories have a stronger bond to selectivity, acceptability and applicability than formal theories. Hence, applicability demonstrates acceptability however, without previous selective acceptability direct applicability is not possible.

These considerations demand a close look into the pragmatic concept of art, and a semiotic analyses of the "aesthetic state" which was developed by M. Bense (14). In that process, based on Peirce's ten sign-classes he extrapolated the now well known:

$$Sc(ae): (3.1\ 2.2\ 1.3)\ ,$$

that means a rhematic sign class with indexical legi-sign. That is an intermediate sign class of the maximaly mixed type and evenly distributed basic categories ("firstness", "secondness" and "thirdness" appear each one twice); only the complete (TS) sign has such an even distribution of basic categories namely six times.

The "aesthetic state" of semiotics, and the aesthetic state of an object as in the case of aethetic measurements, or the aesthetics involved in numerical aesthetics are not to be confused with each other. Ordinary aesthetics are always related to an object as is the case in numerical aesthetics;

$$M = \frac{O}{C}$$

where 'O' represents the organizational relationship, and 'C' the relative count designating complexity. According to Bense et al. ("Die Unwahrscheinlichkeit des Aesthetischen") the relationship between redundancy and intrinsic information generates the elements of aesthetics. But if such is the case then all symmetrical objects do have 'a priori' redundancy (because of the law of symmetry) in relation to intrinsic information in ratio of 2:1, and so will bring about an inherent disadvantage to all unsymmetrical objects. However, that is not a point to be discussed here. Important is that as Peirce, Bense et al. pointed out, not the object per se is the subject of semiotics but its very existence (the objects) as such, and that of course has an indexically (2.2) oriented object relationship through the 'channel' as legisign (1.3) in an rhematic (3.1) context.

It must be differentiated between the semiotic representation of the "aesthetic state" (aeS), and the semiotic representation of the given (presented) aesthetic object itself (aeO). Within the triadic relationship only the index "points" at the "aesthetic state":

Sc(aeS) : (3.1 2.2 1.3,).

The real, presented art object is designated as:

Sc(aeO) : (3.1 2.1 1.2) .

The basics of unspeculative, unhypothetic but theoretically abstracting, operationally reconstructable semiotics are in fact what they are only because the origin, the foundations of functions and methodical processes are basics in their nature: thetical, selectively executable functions. However, just in these thetical principles are the elements necessary for the creation of art and the point where semiotic description touches art. The evident semiotic process involved is thetic, selective, hierarchical supersetting, constructing out of material repretoires and do indeed point to the semiotic origin of art.

These allow the art object to function as representing art object and communicating sign system at the same time. That is what legitimizes semiotical aesthetics as an categorial founding scheme of the numerical aesthetics and allows us to include aesthetics in the general theory of semiotical "mechanics" and the various processes involved in the communicative aspects of semiotics.

The reality thematics of the 'aesthetic state', as already mentioned in the first part of this paper, is:

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                  SC
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1.1 ——< 1.2 ——< 1.3
                 2.2 ——> 2.3
                 3.1 ——> 3.2 ——> 3.3
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The generative semiosis which takes place from index to symbol and from rhema through dicent to the argumental state is obvious. Looking at the reality thematics of the object:

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         SC
         --
1.1 ——< 1.2 ——> 1.3
        2.1 ——> 2.2 ——> 2.3
        3.1 ——> 3.2 ——> 3.3
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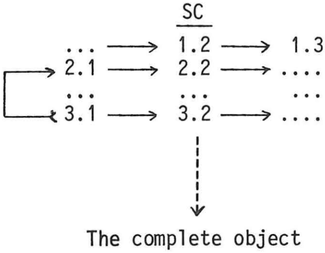
it becomes clear that this is a medium thematized object (2.1 1.2 1.3). In the reality thematics of the 'aesthetic state' we had the vector of the complete sign known also as the 'pragmatic aspect'. The sin-sign, icon, and rhematic interpretant are the characteristics of the object (medium thematized) object. An inspection of both structures above will show that 'aesthetic state' and object are related by the pointer index primarily, and medium sin- to legi-sign modification. This fact may prove that 'aesthetic state' is related to perception (not just a 'pure' theoretical term) within the framework of the communicative functions, and implicitly at least of the human mind.

$$
\begin{array}{ccccccc}
1.. & > & 1.. & > & 1.. & < & 1.. \\
\downarrow & & \downarrow & & \downarrow & & \downarrow \\
2.1 & > & 2.2 & > & 2.3 & < & 2.2 \\
\downarrow & & \downarrow & & \downarrow & & \downarrow \\
3.. & > & 3.. & > & 3.. & < & 3..
\end{array}
$$

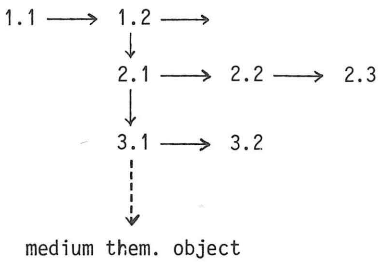
Ideas can be communicated only via icons (2.1) and also all indirect communication is dependent from the icon. That is why each statement must consistently employ one or more icons, or include such signs which again could be explained only with the aid of icons. A case in point is the spoken language in which vocal signals as signs are to be explained only by way of icons. Therefore all perception involves the icon (2.1) and its processing.

That implies that as long as processing of visual perception, visualizing thoughts or both at the same time take place (as when reading a descriptive text) the semiotic (communicative) functions involved are those of a rhematical sign interpretant at one end, and these of the legi-sign media channels at the other side. The increments which are characteristic for a generative semiosis, namely, from the icon (2.1) through index (2.2) to the symbol (2.3) begin at the medium thematized object (2.1 1.2 1.3) and end at the interpretant thematized medium (3.1 3.2 1.3). From close inspection it becomes quite obvious that the 'aesthetic state' (3.1 2.2 1.3) is just the missing link, i.e. the intermediate state in which the medium thematized object (percepted or visualised), is in a "status ascendi", where the index 'points' to the 'address' of a symbol (2.3) which perhaps is not readily available and so stops the semiosis in process in a kind of resonance or oscillation between icon and index. If the cycle is completed and the index's 'pointer' finds the right symbol nothing stands in the way for the channel to give a positive response by means of incrementing its state from sin-sign

(1.2) to legi-sign (1.3) and so arrive at the end of its purpose.



To continue the speculation in this direction it could be said that as long as visual perception, visualizing thoughts or both are engaging the conscious mind, processing 'picture' thoughts the semiotic vectors (as parts of the semiotic matrixes) involved move around a 'fixed' axis of the rhematic interpretant (this is still the communicative function aspects of the sign) at one side and the legi-sign of the medium at the other. The functions of the medium remain at the sin-sign point while processing of one item takes place and then changes to legi-sign. The objects function transfers from icon to index to symbol. A symbol not found (no change from 1.2 to 1.3 in the channel) or wrong symbol (address) may trigger a retrosemiosis only to end into another symbol and perhaps, if no interference comes up from another source, to conclude the cycle, before the next one begins:



In set theory as developed by Georg Cantor, a set is defined as a collection of real or abstract objects. Sets such as the set of all real numbers, for instance, are by their very nature actual infinities and impossible to visualize abstractions. In case a symbol (absolute subjective) has been 'stored' and may be 'found', semiosis will take place, otherwise the mind goes into the 'aesthetic state'. Now consider a set of five elements, say five apples. There is no problem to visualize five apples but if the set of elements or apples are increased to say five million or for that matter five billion the human mind goes into the 'aesthetic state' because of the unfulfilled semiosis which does not take place between the object-index at one hand and sin-, legi-, quali-signs at the other, as already explained above. This implies that semiotical 'aesthetic state' and the notion of 'fuzzy' sets have common roots and perhaps involve the same semiotical mechanics when analysed for their communicative aspects.

The thesis is advanced here that the semiotical process is fundamentally of a self similar nature. Specifically, it is postulated that any representation of information inherent in all elements of a system during information processing will preserve the scheme of *functional, triadical signrelationship*.

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