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THE RELATIONSHIP BETWEEN EVOLUTION AND INFORMATION

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For most of us, the word evolution is associated with the name of Charles Darwin. In this study, the concept of evolution will be employed in a much broader sense than in that of Darwin. Evolution will be understood not only as a spontaneous constitutive activity of the "big bang", which shapes the universe including the Earth, but also as human activity creating culture. Schematically speaking, evolution will be understood as natural and cultural "construology", which produces forms, order, memory, and information. Since the cultural system is only formed by the reconstruction of older, naturally created structures of the planet Earth, it is evident that cultural evolution does not fit in the framework of natural evolution.

Natural and cultural evolution

Although *cultural evolution* differs qualitatively from natural evolution,[1] and in spite of the fact that it relies on other sources of energy and other constitutive information—even with a significant share of human theoretical activity—in principle it is blind. Like biotic evolution, cultural evolution also uses the verified model of testing its constructs by the conditions of the environment, that is, "the biological method of the cooperation between genotype and phenotype" (see Šmajs 2000).

The fundamental difficulty in defining natural evolution consists in the fact that empirically determinable evolutionary changes take place in much longer periods of time than the daily, yearly and life cycles of humans. While our ancestors were

[1] The concept of evolution probably emerged for the first time in the work of M. Cusanus *De docta ignorantia*. This term has been used in life sciences for at least two centuries: not because the development in that area has been most evident (by contrast, it is easily determinable in the field of human culture), but because the mystery of evolution was uncovered there for the first time. The transformation of the somatic forms of the ancestors of recent organisms was discovered first by fossil findings and later a hidden mechanism of the spontaneous change of their inner structural information (Lamarck, Darwin, Mendel, Morgan, Crick, etc.) was partly uncovered.

biologically well equipped for the passage of time during the day, for the perception of the shape, mechanical motion, or the potential function of things before the emergence of culture, slow spontaneous structural and processual changes cannot be reliably registered even by contemporary science and philosophy.[2] People are thus products and components of natural evolution and real creators and actors of cultural evolution, but by the ideological reconstruction of the nature and the encounter of both these evolutions, they depend on the partial knowledge of special sciences and the aptitude for an adequate philosophical vision of the world.

This is probably why evolution still remains a suspicious, mysterious concept difficult to understand even by the intellectual public. This was also noticed by the protagonist of the evolutionary approach, P. Teilhard de Chardin:

> To many people, evolution is still merely transformism and transformism is only an old Darwinian hypothesis, partial and feeble as Laplace's concept of the solar system or Wagener's continental drift. Who does not see the breadth of motion, the pathway of which has by far gone beyond the limits of natural history, gradually hitting and filling chemistry, physics, sociology, and even mathematics and history of religion... is really blind...Evolution is not a theory, a system or hypothesis, it is much more: from now on, it is a general precondition, which all theories, hypotheses and systems have to comply with if they are to be thinkable and correct (cf. P. Teilhard de Chardin, 1955, 242).

Stephen Jay Gold,[3] the well-known evolutionary biologist and populizer of science, is also convinced of the extraordinary importance of the evolutionary theory for the scientific interpretation of the world. The leading figure of the "Brussels school" Ilya Prigogine is an ardent defender of evolution:

> Wherever we look, we find evolution, diversification, and instabilities. Curiously, this is true on all levels, in the field of elementary particles, in biology and in astrophysics with the expanding universe and the formation of black holes (Prigogine, Stengers 1984, 2).

Although we know that it is difficult to express current outlooks on evolution by several theses and that there are still authors, who deny evolution, we point out that there is currently a wide spectrum of knowledge and theories of different level of universality available to the philosophical conception of natural evolution. On this basis we can expect (for example in agreement with P. Teilhard de Chardin and Henryk Skolimowski) that at the beginning of the universe, its organization was at the lowest level and that it increased gradually only by evolution. It seems logical

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[2] Authors of different orientation agree in the interpretation of this problem: "Our cognitive apparatus has no special organ for grasping the life...it has a highly developed organ for understanding things..." (Hartmann 1964, 33).

[3] Gould identifies three important features of evolution theory: first, it is itself developing, but strong enough and simultaneously not consummated; second, it is in the midst of many scientific disciplines studying timeless general phenomena up to the particulars of the development; third, it is concerned with the life of us all (cf. Gould 1980).

that at the moment of the so-called "big bang" almost all orderliness of the potential previous universe could have been destroyed, lost or washed down.

According to H. Skolimowski, who tries (to some extent like Teilhard de Chardin) to construe spirituality as "an aspect of the weaving evolution":

> No, evolution is not a stupid and chancy process of stumbling upon one beneficial variation after another. Evolution is so exquisite in its mode of operation that it could be called divine. I, myself, have no difficulty in accepting the idea that God is evolution and evolution is God... (Skolimowski 1992, 235).

Natural evolution, as has already been indicated, is a spontaneous constitutive process within the current tendency of the universe towards expansion and cooling, that is probably also towards "amortization" of the original concentrated activity of the big bang. It seems however, that as an independent antientropic activity it was stimulated by a random disturbance of the symmetry of the universe.[4] It is as if specific forms of creative universe activities have continuously crystallized since then, not only in the structures of the galaxies and stars, but after the Earth was formed as a planet also in the remarkably subtle order of the living nature on the earth. *If the natural evolution has any deeper sense, then it is the construction of such a magnificent structure of the universe, creation of its unprecedentedly complex structure, which includes the whole natural order (information, memory) of the planet Earth.*

All chemical elements of the periodic system represented today on the earth's surface were formed—with the exception of hydrogen and helium—in the ancient universe: as a consequence of nuclear reactions inside the stars of the first generation, or during their extinction.[5] That period lasted about 10 billion years and it was absolutely necessary for creating the abiotic building blocks of the earth and life on it in a natural way. Chemical pre-biotic evolution, which created the first organic compounds (aldehydes, hydrogen cyanide, amino acids, protenoids, nucleic acids, etc.) in the atmosphere without oxygen, could, like the further development of life—have taken place already on our mother planet.

Summarizing our arguments, we can say that the gigantic process of the evolution of the universe created elementary particles,[6] atoms, molecules, cosmic objects,

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[4] Barrow indicates this asymmetry, which might have been formed from the asymmetry of the decomposition of the hot dense state of the universe, on the ratio of protons. He thinks that there must have been one billion plus one proton per each billion of antiprotons on average (cf. Barrow 1992).

[5] "During the explosion of supernovas and other explosive processes in the universe these elements enter the interstellar space and provide conditions for the formation of new stars and also objects, unimportant from the universe's point of view, like our Earth" (Krempaský 1986, 131-132).

[6] F. Capra shows that also the world of elementary particles is complex enough and that for today's number of particles (around one hundred) the attribute 'elementary' is not precise enough (cf. Capra 1975).

the Earth, its minerals and relief of its landscape, water, soil, biosphere including the biological ancestors of modern human. *The natural evolutionary creativity can thus be understood as the second general potency of the spontaneously active reality—recognized only recently—which cooperates with the first potency, known earlier as a tendency towards the growth in entropy.* Evolution is thus a spontaneous creative ability of reality, put into effect both under the special cosmic conditions and under the special earthly conditions. This process takes place on the Earth chiefly in open non-linear systems, in the so-called dissipative structures. In the universe, it apparently takes place under particular conditions, which are difficult to understand by the people living on the Earth: for example, hydrogen (like all quarks and electrons) does not arise in the present considerably cold universe any more (its average temperature being –270 °C);[7] on the other hand, chemical elements are still being formed in the stars and supernovas of the universe (Kleczek 1998, 121).

Since evolution—in contrast to entropy—is an ontically constitutive process bound to certain conditions, it can collaborate with the general decomposition, "to live as a parasite" on it, and can, as is relatively clearly visible in cultural systems, entropize the environment secondarily. Even in its spontaneity, it is a process fully independent, which, in opposition to the tendency of the reality towards decomposition, selects and seeks, experiments, creates and destroys. Thus natural evolution builds increasingly subtler and more differentiated emergent structures and the rules of their formation and functioning, *spinning the web of ontic plurality of the reality—the structured order of the universe.*

Since evolution, metaphorically speaking, proceeds "against the current", against the tendency towards general decomposition, it needs an adequate energy support, "nourishment". If we only look at the energy nourishment of biotic evolution, it seems that it is the limited possibility of photosynthesis to bind solar energy to the biomass that is the reason for the resourceful ability of the biosphere to face entropy in all organizational ways imaginable, to slow down the degradation of the biotically bound solar energy into waste heat not usable any more. Thus, this spontaneous creative ability of life was ultimately objectified and recorded in an immensely complex ordered system of the elements of its earthly ecosystem.

Biotic evolution, which creates blindly, but so slowly and "thoughtfully", that its constructions almost do not morally grow old, consumes the greater of the accepted

[7] If it is true that the current structure of the universe was ultimately formed by the secondary condensation of matter and energy dispersed from the original hot singularity, then from a certain point of view the thermal death of the universe, which had once discomposed physicists and part of the public, has in fact already come. Relict radiation formed by photons, which succeeded in escaping "in the moment of translucidity of the universe" (300 thousand years after the big bang) brings, *inter alia*, the news that the average temperature of the universe is only three degrees higher than the absolute zero, that is 3 °K.

energy nourishment for maintaining, functioning and reproducing the earlier created ecosystem of the biosphere. With regard to the fact that the living systems are rather close to information, only a negligible residue of the natural ecosystem energy can "crystallize" in an increment of the ordered system, that is in the new organizational complexity, in new functions and emergent constructions.[8]

The situation is different in the case of cultural evolution, which is much more open to new sociocultural information and which is only learning the perfect "natural engineering". This evolution has partially been liberated from both the direct dependence on the biotically bound ecosystem energy (for example technical civilizations discovered the way to use the concentrated sources of energy, primarily fossil fuels) and the dependence on a few chemical elements of the periodic system, which earthly life uses for building its structures. A considerable part of energy (activity) is also consumed for the functioning and reproduction of the earlier formed cultural system. The more extensive is this system, the greater is the lost part. However, with regard to the rich energy resources of the Earth, to an incomparably wider range of choice of the "building material" as well as with respect to the more flexible sociocultural memory—spiritual culture—the global culture is not under threat of direct energy, material or innovative deficiency. There is still enough energy to create new elements and subsystems of the cultural system, for progress and growth: therefore, a great part of cultural activities crystallizes today in deliberately and spontaneously constituted structures. The amount, diversity, and complexity of cultural artefacts are increasing, more or less in proportion to the growing energy consumption of culture.

In a general philosophical formulation we can say that *evolution generates, destroys and modifies the elements, complexes, subsystems, and systems so that the diversified aggregate, in its increasingly ordered system, is more and more economical in using its limited evolutionary source:* for example the biosphere uses the energy of the sun's radiation, culture uses the energy exerted and released from nature by people.

Cultural evolution, which is several orders faster than natural evolution, and which also includes the aptitude for spontaneous ontic creativity (reproduction, reconstruction, innovation, etc.), has been closely associated with increasing energy inputs. And since the energy needed for the reproduction and evolution of the cultural system can come either from the solar radiation (particularly from recent or fossil biomass) or from other forms of the earlier condensed activity of the big bang (for example from geothermal or atomic energies), the spatial growth of culture cannot correlate with causing damage to the natural structures of the Earth, with the dangerous reduction of the area of natural ecosystems and the variety of life, in particular.

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[8] The natural climax ecosystem can serve here as a good example. Under normal conditions, there is in it an approximate equilibrium between what constantly grows and what is simultaneously decomposing and again is used for growth.

Life as the finest aptitude for ontic evolutionary creativity of the universe is, of course, realized under very delicate local circumstances: *on the planet Earth and within an extremely narrow range of physicochemical conditions.* These conditions, which, to a considerable extent, are later co-created and regulated by the biosphere itself and which have not yet been specified in philosophy also because the course of the evolution of the biosphere is not sufficiently known, include not only the weakening ozone layer that protects life from ultraviolet radiation from the universe but also the damaged all-planetary thermostat of the Earth. Fortunately, it is already known that our planet creates a single large organism, Gaia, and that we must not toy with the self-regulating structures of life.[9]

The complicated question concerning the beginning of life can be recalled only briefly here. Complex organic molecules could have also been formed in the free cosmic space but the majority of the renowned authors agree that life could have begun to its full extent also on the Earth. Its crucial question was the functional integration of the subsystem of inner memory into the living system.

However, in the further development of life, we are facing two philosophically important issues. First: In the biotic evolutionary process we find something that we know well from the history of human culture: unevenness, that is, slow phases and rapid evolutionary jumps, steep ascent after reaching a certain threshold value of development. Referring to the fossil findings, S. J. Gould expressed it in a lapidary way, saying that only about 600 million years ago, there emerged practically all fundamental forms of the earthly animal life in fossils (Gould 1980).

This break followed by a rapid acceleration in the development of life, sometimes denoted as the "biological big bang", was probably connected with getting above the surface and with the "discovery" of the new biotic building block principle—the eukaryotic cell,[10] but also with the fact that with more complex structures, the evolution could proceed not only in parallel but simultaneously also at several organizational levels. It reminds us of the European cultural situation after the industrial revolution: the coping with instrumentalization and the achievement of the threshold value for rapid technical and generally cultural growth in nineteenth-century Europe. An analogous evolutionary mechanism has also been implemented in the development of abiotic technology after the advent of mechanization

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[9] The Gaia hypothesis of J. Lovelock appeared in connection with research concerning the issue of life on Mars. It was inspired by the idea that the stability of the temperature and chemical composition of the Earth's atmosphere requires the existence of an active control system. According to the author, biosphere regulates and maintains the climate and the composition of the atmosphere to be optimal for the existing forms of life. Of course, it does not mean that it is hypothetical or planned regulation because its formation is spontaneous–like the formation of the inner memory of the living system (see Lovelock 1988, 42-64).

[10] According to S. Lem, by creating an eukaryotic cell, a foundation brick of the biological building material identical in its main scheme both in trilobites one billion years ago and in current chamomile, octopus, crocodile or human, was formed (Lem 1995, 23).

and automation: rapid differentiation and overlapping of all historically discovered technical principles and elements (see Šmajs 1988a; Šmajs 1988b).

Second: There is an insufficiently reflected problem of the two different types of natural biotic ordered system that is worthy of theoretical attention.[11] In the sphere of life there is a demonstrable difference between the strictly informationally prescribed *ordered system of a particular organism,* that is its genotype and phenotype ordered system and the *ordered ecosystem* not prescribed by information. The multicellular system also necessarily grows from one cell (zygote) and its multilevel organization, including the process of ontogenesis, therefore has to be inscribed in the structure of its heritable memory. A considerably flexible ordered ecosystem, similar to the ordered sociocultural system, is created by succession and therefore, it can probably be integrated only by mutual food and reproduction dependence of living organisms, mediated by their ontogenetically acquired knowledge. Thus, the ecosystem has neither free nor bound internal information, which would be passed on vertically and which would fulfill the function of its anti-entropic barrier.

These two different types of ordered system, that is, these really different relations of information and structure, also have their analogous sociocultural counterpart. Information discrepancy is also found at the level of the culturally ordered system between the strictly prescribed order of the particular human artefacts (for example buildings, technical systems, daily bread, etc.), which can partly be encompassed by the individual human mind, and the freer sociocultural order at the level of the tribe, village, town or the whole local culture, which cannot be encompassed (and thus cannot be created) by any human individual.[12]

Although natural or cultural information necessarily participates in the development of both types of ordered living or cultural systems, the course and the result of the evolutionary process is always more or less unknown, undeterminable and unpredictable. And that is not only because the scattered horizontally flowing information of a more freely ordered system (ecosystem, local culture) arises together with the system in the process of its constitution and transformation. The result is not clear in advance also because the evolution of the strictly informationally prescribed constructions (for example the organisms that make up the system) does not

[11] We leave out the abiotic area, where it is more useful to think about constitutive or linking forces (bonds, physical interaction), rather than about the inner information (memory) of the particular structure.

[12] There is also an approximate analogy in the abiotic earthly nature. Minerals and rocks formed in the Earth (or in Earth's crust) are subjected to entropization, they disintegrate, decompose, and from their secondary abiotic order, the fertile soil is formed with the participation of the living systems. It is precisely the organization of the soil that can serve as a good example of the formation of the free "ecosystem" order without the existence of concentrated inner information. In this connection it seems that Prigogine's dissipative structure theory, derived from the chemical systems and reactions, is primarily valid in the area of the changes in the ordering not prescribed by information.

take place as a mere implementation of the scenario. By contrast, it is a complex dynamic interaction between information and the environment (context), as an interaction of genotypic and phenotypic structures organized in the matter-energy world. Therefore, not only information change but also the possibilities of the manifestation of the inner information in particular conditions are determining. It even depends on the form, behaviour or "success" of living or cultural constructions. Evolution is thus co-determined by many casual factors at all organizational levels of reality. It is evident in the development of the living systems but it can also be illustrated by the development of culture. Spiritual culture, which has no analogy in nature (no ecosystem or biosphere as a whole contains such information), can, however, anticipate or regulate the results and trends in cultural evolution in some ways.

The perspective of evolution, concretized and specified by special sciences can thus become a new principle of the interpretation of the general philosophical vision of the world–philosophical ontology–which has struggled for centuries with the questions of the origin of the world, of what is its essence and of what is it composed of. Particularly due to the progress in physical and biological sciences—primarily in non-equilibrium thermodynamics and genetics—we begin partly to understand the general rules and order of "natural construology", that is the essence of the spontaneous creation of complex natural structures from relatively simple elements and components.[13] Thus, we also have a better understanding of intentional and spontaneous cultural construology: although it is oriented so that it consumes and dangerously harms the natural earthly structures, it grew from the natural order and remained interconnected with it through humans, inclusive of the direct link to the natural ecosystem energy, variety of life, and conservative genetic information.

Everything that seemed to be created, eternal and immutable between Aristotle and Newton, has to be declared today as emerging and dying away, as unfinished, transient and changeable, as a part of a large divergent evolutionary process, which has a beginning and maybe also an end.

Inspired by Prigogine's contemplations on the relation between stability and variability in science, we can say about evolution that its exploration not only gives the privileged place in the universe lost for some time back to the Earth. It lifts it up to heaven for the first time. Creation, destruction and change, which, according to Aristotle, belonged to the sublunary area, that is, to the Earth, are inseparable properties of the whole universe known so far.

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[13] Natural evolution is thus created by all "growing" branches of the divergent evolutionary process of the universe. Its product is therefore not only a number of galaxies and stars–there are about 100 billion galaxies in the universe with about 100 billion stars in each of them–but also the dynamic structure of the contemporary universe including the abiotic and biotic structure of the Earth.

The issue of information

The understanding of the essence of information is primarily complicated by the lack of courage to identify what has been clear for several decades: *natural, biotic information—and human, sociocultural information.* Apparently, as a consequence of traditional upbringing and school education there is a prejudice that information is created and used only by humans and society. It is, however, a simple anthropological delusion, which follows from our wrong approach to reality.

We have already said that the structures of reality, including ourselves, are created, changed, and usually also disturbed by evolution. It means that reality is not stable, that it is not created at one time. It is as if reality crystallizes and dissolves in the flow of time, it arises and vanishes. All contemporary structures of reality could have only been formed in two ways: either by *natural evolution of the universe or by cultural evolution.* There is no third possibility. In other words, all that exists today–including information–owes its formation and existence either to the spontaneous activity of the universe or to a special and temporary human, sociocultural activity.

Information is thus of the same origin as reality, it belongs to reality, it is its aspect—as matter or energy are its aspects. Information is not only a message, it is also an orderly system, its organization, its structure. If we do not doubt the existence of matter and energy, we should not doubt the existence of structure, information, either.[14]

In a rather provoking formulation, we thus maintain that information is the most important product of evolution, that it is its ontic expression, its final "sense". In the earthly environment, it is seen with the naked eye quite clearly: evolution on the Earth does not produce either matter or energy because the conservation laws are valid. Evolution produces structures, forms, organization, order, that is, information. Information is obviously produced by both natural evolution and cultural evolution. No conservation law is valid for either of these types of information.

Information (the measure of memory) is a special product of evolution, which not only integrates open nonlinear systems, both living and cultural, but also *differentiates reality ontically.* In contrast to the visible forms of evolution, which are in an explicit order, information is not easily accessible to human knowledge, because it exists in nature primarily in the implicit order.[15] The *natural biotic information,* which is as old as life itself, once divided the formations of an earthly nature into two generally recognized layers: *living and nonliving structures. The sociocultural information* formed three billion years later was similarly constitutive: it was even ontically more radical because it helped constitute culture inside the earthly nature,

[14] Half a century ago N. Wiener presented a classical definition of information adjusted to the contemporary definition of cybernetics (cf. Wiener 1950).

[15] Although we use the terminology of D. Bohm, explicit and implicit orders of reality are understood differently: as two different orders within the ontically uniform nature and two different orders within the opposite ontic layer of culture.

which had been uniform until then and *young cultural systems were "placed" into a potential ontic opposition to it.*

The problem of understanding the quintessence of information is complicated by the fact that information and reality are related products of evolution and that each piece of information refers to the structures formed by evolution or—as metainformation—to another information about structures. Since the surface of the earth was highly ordered before the existence of people, its natural memory structures[16] represent potential (accumulated) information for all systems with cognitive ability.

The concept of information was spread as late as in connection with the development of cybernetics (Shannon, Wiener) but mathematical analogies between the measure of information (the information content of negative entropy) and entropies caused that it became a concept complementary to that of entropy in thermodynamics and in the general theory of systems.[17] Owing to its many meanings, it soon found its place in all theoretical and communicative situations, in which subject--object and subject-subject considerations are applied.

In the inorganic world, its structures already influence one another not only materially and energetically but also structurally-informatively. The first real information, that is both as ontically constitutive *structural information* (a duplicate of system orderliness) and as "complementary" *semantic information* (semantic, behavioural) is spontaneously created, cumulated and used by natural biotic evolution. Information in both these forms therefore arose and fulfilled ontically creative functions long before the existence of people.[18]

The first one-celled organisms survived and reproduced themselves in the earthly environment three billion years ago due to the fact that they used knowledge—*their own structural and semantic information.* Therefore, we shall not understand without the concepts of information and memory how can the highest earthly organizational complexity—autopoietic system of planetary life—be self-producing.[19]

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[16] In living systems as natural memory structures, information is encoded in two ways. First, it is encoded in the information (memory), that is, a genotype, structure and secondly, in somatic, that is a phenotype structure.

[17] C. E. Shannon was probably the first to formulate mathematically the anticipated connection between information and entropy (Shannon 1948, 379-423).

[18] Schematically, every linguistic record (equivalent) of the real structure, which is structurally isomorphous with reality (system) to such an extent that its "objectification" minimizes the need for interpretation, can be regarded as structural information. In semantic information, the problem of uncovering the meaning arises.

[19] We intentionally leave without a detailed commentary the basically identical opinion of H. Skolimowski, who, in our opinion, mixes up in vain what we try to discriminate consistently: namely, the *a priori* genetic memory and the *a posteriori* epigenetic neural memory. "It is easier to postulate that life is knowledge and that life and knowledge are linked together than to explain it" (Skolimowski 1992, 125).

In the processual evolutionary ontological approach, both structural and semantic information are thus part of evolution—being everywhere, where there are systems (structures) and material-energy changes. Evolution—natural and cultural—creates not only an objectified orderly system of reality (explicit memory, order) but also its unobjectified, ontic potential (implicit memory, order) orderliness.[20]

The concept of information is not so broadly understood either in philosophy or in social sciences. A narrower meaning of the concept of information predominated probably for better understandability, that is, it is usually understood merely as knowledge, message, the meaning of the message, that is *semantic information* and, only exceptionally, also as a copy of the orderliness of the structure or system, that is *structural information.*

The distinction between the structural and semantic aspects, which is not easy to make even with regard to natural information, where the fractal of genetic information can be regarded as structural information and its complementary neuron epigenetic information as semantic information, is further complicated in the cultural area. Among other things, domination has changed. Scientific theoretical knowledge as a prototype of the partial structural information, which can be objectified in material culture including technology, and which today participates in significant transformations of the globalizing technical society conforms to the greater system force of less complex semantic information, which is, however, more compatible with reality.[21]

Although the broadest possible understanding of information does not oppose the spirit of evolutionary ontology, from the position of which we argue, we shall further respect the influential biological convention and understand the natural structural information in accordance with it: primarily as a content of the genetic memory of the system, as a supporting subsystem, which is created by a set of elements, rules, directives, algorithms, etc. Under semantic information, we shall understand part of epigenetic information—neuron information stored in the central nervous system of animals.

Special *evolutionary superiority is immanent to the structural information,* to the sociocultural form of which we pay much attention, is already at the level of living systems. Because it is formed in a long process of phylogenesis and becomes, after the necessary selection, the content of the *a priori* structural memory of the living system (its genome), it has, inside this system, a "privileged" position;

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[20] This duality apparently has a much more deeper meaning than approximate philosophical intuition can grasp. One of its aspects is definitely also the testing of the compatibility of information-prescribed "construction changes", by complex physical action of the external world.

[21] A more precise definition of epigenetic information, or a single adjective "epigenetic" is problematic even on the cellular level. If we omit the unclear role of protein regulating molecules, it is obvious that an epigenetically determined process can be inherited with the same precision as a process determined by genetic alteration (cf. Darnell, Lodish, Baltimore 1990).

that is it helps reproduce its evolutionarily created structure and it also plays a dominant role in the relation of the system to the environment. For example, the *a priori* structural information of the living system determines, which matter-energy flows will be relevant for preserving the system and thus, if we put it like this, it adjusts the organism with respect to the surroundings also "semantically"—to the acceptance of the structure of potential meanings adequate to it.[22]

By taking the evolutionarily ontological position, we do not underestimate the importance of semantic information;[23] but understandably, we favour the role of structural information. We also try to grasp not only the ontically constitutive function of the inner information of the system, but also the opposition of natural and artificial memory of ontic structures secured by memory. Since *all structures on the planet Earth are products of either natural or cultural evolution,* we should recognize that there are only these two ontically creative processes, which produce and use spontaneously their own inner information. This is also the reason why, besides the mentioned distinction between semantic and structural aspects of information, we have accepted *another essential classification:* the division of information (memory) into *natural* and *cultural* (artificial).

The ontic role of sociocultural information

Biotic systems do not gain and gather information in order to enjoy the recognized truth. Their cognition, although it also includes features of redundancy, is subordinate to life. Numerous ways of biotic cognition of the environment, that is for instance the blind interaction of mutations and selection, which maintains and changes the genome and the more or less "intentional" sensory cognition of animals with the central nervous system, which enables adaptation to the particular life conditions, have a clearly pragmatic purpose: since it concerns the knowledge compatible with the surroundings, it secures the long-term possible physical reproduction of the living systems, their adaptation to the external world and the slow ongoing evolution. Biotic knowledge is thus an aspect of the spontaneous creativity of life. It participates in the growth of the natural order (memory) of the biosphere, in the creation of the irreplaceable wealth of information of the Earth. In this sense, it is ontically and axiologically constitutive.

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[22] The metaphor of "semantic configuration" can, however, be effectively used in a narrower sense of the word. For example, the sociocultural memory of an individual, an ethnic group, or the whole regional culture must be semantically properly configured, because it also serves the survival and self-assertion of its proponent. Wilson's "epigenetic rules", as "...the hereditary regularities of mental development that bias cultural evolution in one direction as opposed to another..." (Wilson 1998, 319) can also be understood in approximately this way.

[23] Two different biotic structures carry the natural structural and semantic information even on the cellular level: in eukaryotic organisms it is a schematically cellular nucleus and a plasmatic membrane. In higher multicellular animals, the ontogenetic semantic (epigenetic) information is primarily stored in their CNS.

The idea that beside the knowledge focused on truth, the cultural system depends on knowledge, whose assignment is less dignified: to ensure the existence, reproduction, and evolution of culture, has not been self-evident for philosophical contemplations for two millennia. A constantly growing overproduction of free sociocultural information concealed the fact that culture could exist only as an open nonlinear system with active cognitive activity, as a system, which changes, absorbs, and objectifies information–its own non-biological knowledge much more obviously than the biosphere. Although this knowledge is, in comparison with the knowledge of "unambiguous content", biotically vague, one-level and fragmentary, it is analogously ontically productive as the historically older knowledge of the living systems. If metaphors of the Chilean philosophizing biologists U. Maturana and F. Varela are valid for these systems, namely that "each action is knowledge and each knowledge is action" and that "life is knowledge" (Maturana, Varela 1987), then an analogous thesis also has to hold for the cultural systems: *culture arises by objectification of its own sociocultural knowledge, its own cultural information.*

Before analyzing the above idea, it is useful to stress that culture is a dissipative structure, that is the *"physical" system*, which, like a "genome" *contains a rapidly growing spiritual culture—free sociocultural information.* The constitutive role of sociocultural information can therefore be understood not only by an analysis of its special content, but also by the system evolutionary interpretation of the open nonlinear system of culture. This system must build up, reproduce, and transform its body analogously to the living systems: to the detriment of the consumption of material and energy nourishment from the external environment.

We again call to mind that the system of the particular culture, its whole, which is able to exist and evolve, can *only* be formed by *phenotypic structures of culture.* They became the new environment of human life and the indicator of the technical and social maturity of culture and the most dependable *measure of the ecological adequacy of spiritual culture.* Since these structures are today a direct cause of irrevocable harm to the earth's natural environment, a question is justified, how is the ecological crisis conditioned by information (by the content and structure of the sociocultural knowledge) and whether it can be solved on this level.

At first, however, there are two preliminary notes as to the content of sociocultural information. First: this information is singled out from natural epigenetic information (neuron, semantic, *a posteriori*) and then it is divided into sociocultural structural and semantic information. With regard to the evolutionary adaptation of the neurosomatic structure of humans to the factors of the natural environment, which were essential for the survival and development of the life of our ancestors, it was redundant that the human cognitive apparatus would be more sensitive[24] and

[24] J. D. Barrow points out to the sensitivity of our senses in an interesting way. For instance, he says that their sensitivity must not be too high (Barrow 1992).

to be constructed for the direct revelation of what has been named implicit order and is today called scientific truth. *It was the survival in ecologically steady conditions that was at issue rather than the truth.* For the sustenance of culture, it was not crucial until the beginning of the global ecological crisis whether people had an adequate image of the world, whether their knowledge of nature in its evolutionary process and the whole was objective and true. Since the natural conditions of the cultural life were reliably reproduced by nature itself, it was sufficient for humans to get to know it only on the local and topical level—to focus on the self (of course, by means of the cultural system). The point was to be adequately socialized, to communicate well, and to orient and adapt correctly. *The truth in ontological questions, about the interpretation of the world regardless of the current visions of the status of humans in the world, even regardless of how humans experience the world, has become an issue only today.* To express it in terms of the structural and semantic information—it was the component of sociocultural semantic information that dominated the evolution of the cultural systems in the past.

Second: non-biotic sociocultural information, which enabled culture, had *a special content* from the very beginning. It did not contain merely the knowledge. But even the knowledge, which it embraced, had one feature in common. It was formed in a highly selective way, or, to be more precise, by a "*special reading*" of the surrounding natural and cultural organization by the human senses and mind. This knowledge was not concerned in the first place with the internal structure of things and living systems, but, if we use the characteristic terminology of modern philosophy and science—with the so-called *primary qualities of reality.*[25] Long before the advent of modern natural history, European culture evidently encouraged practical orientation: an interest in the cognition of the parts of the world isolated from its residues, orientation towards the cognition of the form,[26] size, motion and the orderliness of things in the limited space of human interests. The magic power of the conceptual ideals of this culture, which were, for instance, an object of Husserl's criticism in *The Crisis of European Sciences*, did not cause, however, only deformation of the theoretical image of the world: it structured the whole social material culture against nature.[27]

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[25] The spirit of mechanical natural history, usually criticized only on the level of gnoseology, is probably so compatible with the biologically predetermined dependences of humans on the success of their offensive adaptive strategy that in the sphere of practical technical applications of science it does not have to face any public protests even today.

[26] K. Lorenz appreciated the exceptional significance of the perception of the forms in humans. He compares the precision and stability of the perception of the forms to a miracle, which is able, by a certain configuration of signs, to store precisely the data perceived into the memory from the chaotic background for years (cf. Lorenz 1993, 43).

[27] Husserl points out to the forgery of the mathematically structured world of idealities for a real world which is given to us, when perceived, that is the pre-scientific "natural world" (cf. Husserl 1972, 70).

Although the European theoretical orientation was not the only one (for instance, the Eastern holistic perspective was sustained in parallel to it), it was the one to open the way to technological exploitation of nature regardless of its systems connection, its nonlinear character, evolutionarily created orderliness and balance.

We shall now try to bring the complicated structurally constitutive role of the historically and locally variable sociocultural information closer by comparing it with the structurally constitutive role of the natural genetic information.

The natural genetic human memory is the structural species memory, highly stable, capable of replication and self-reparation. In order to be its real "production documentation", to be the programme of its ontogenesis, it has to encompass all relevant information about the organizational structure and compatibility (commensurability) of human body with the environment—it has to be the *molecular interactive memory, communicating and highly objective.*

This natural memory structure is part of the implicit order of the slowly developing planetary life. It includes the structural constitutive information, where the historical evolutionary experience of the species is inscribed in the universal conservative language of nucleic acids.[28] With regard to the complicated mechanism for inscribing of the new information, where the spontaneously generated information changes, mutations, and selections play an important role, it is almost impossible to enter the human genome: the external and internal human environment does not influence the information content, it is not possible to communicate in an ordinary ethnic language.[29]

Special structure–information isolations of natural biological constructions from the permanently changing external environment can be one of the causes of the slow moral ageing of biological species, but its evolutionary meaning is positive as a whole: it helps to reproduce the biological diversity of life formed by evolution, it protects biological species against extinction, that is against the irrevocable adaptation to the temporarily changed life conditions. To be able to react promptly to the variable external environment, all animal organisms are equipped with another, more adequate mode: "*the evolutionarily semantically set" nervous system.*

However, the *language barrier*, which we encounter in gene manipulations, is not a hindrance to the "inscription" of neuron information about the external envi-

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[28] The gene pool of the human, who is "twice wise", is the objective constitutive information of a "normal" biological species, which is very stable and therefore, it corresponds to a slowly changing biosphere. With regard to its delayed and limited reaction to external conditions, it is actually adequate to the biosphere, which once shaped our biological ancestors—the hominids.

[29] Although it has never been proved that the social adaptation of humans can be fixed into DNA, there is still a surprisingly considerable interest in this unproven hypothesis. The research on the so-called genetic assimilations dealing with the biological coming together of once separated living populations seeks to confirm it.

ronment in the genome of an individual or the gene pool of the population. There has been an *insurmountable physiological barrier* so far: the gap between the genetic memory, located in the nucleus of the cell and partly also in some cellular organelles, and the epigenetic memory, which is located in the cell and chiefly in the structure of the bonds of neurons. In other words, inside the living systems, there is no two-way link between these two different memory structures. At the lowest organizational level of the living systems it has been expressed in a lapidary way by the so far valid central dogma of molecular biology, which, among other things, also argues that the transfer of information from nucleic acid to protein is possible but it is not possible in the opposite direction.[30]

The natural epigenetic human memory, primarily its part, the memory of the gray matter of the brain, from which a biotic carrier of sociocultural memory with complex structure is being created during cultural evolution, is, however, in its biological essence, a supporting, short-term memory. In spite of the continuous cultural tradition, its individual content is always formed only after the life experience of an individual and disappears with her. It does not concern either the complex stratified structure of the human organism or the majority of layers of the abiotic and biotic environment of the Earth. As has already been mentioned, without adequate scientific and philosophical cultivation, its content concerns only fragments of one level of the macroscopic structure of reality. It co-creates our natural image of the world, which is necessarily partial and deformed by species (selfish) and which cannot be inscribed into the genetic memory.

The sociocultural memory of society formed from the human natural epigenetic memory, in the content of which the distinction between the information semantic and structural aspect makes sense, is not easily noticeable as to either the content or the functioning. In contrast to the ontically reliable genetic memory, which is the memory of our whole species, and which ensures its somatic and behavioural compatibility with the environment by the high degree of direct molecular interactivity, our newly formed sociocultural memory cannot guarantee any similar compatibility of culture—*it is not "objective" enough.* We have already pointed out to one of the reasons for this non-objectivity, that is, to the derivation of the content of sociocultural information from one level of the phenotypic structure of reality, from the so-called primary qualities. However, there are also other reasons.

For instance, the one-way process of the replication of the genetic information is implemented in a cell or in its nucleus on the basis of direct deterministic copying. The high reliability of this process is ensured by the fact that together with the par-

[30] This dogma was formulated as early as in 1957 by F. H. C. Crick. Its "validity" can probably be extended to the area of practical applications of cultural information, when the encoded information does not spontaneously flow from human artefacts to the heads of the users.

ticular information also its carrier—the DNA molecule—is passed on to the new host (somatic or reproductive cell). This is the difference between the vertically strict deterministic transfer of genetic information and the vague, potentially infinite spread of components, news, and the knowledge of sociocultural information, which is accessible to all people and therefore misinterpretable. The sociocultural information is primarily spread horizontally and with regard to the method of inscription, it exists not only in dispersed and fragmentary form, but also in a form more freely interconnected with the world and with its language carrier. Obviously, also a wide-ranging polysemantic ethnic language makes it semantically widely unstable.[31]

We shall try to give a better explanation of the content vagueness and the variability of the ontic role of sociocultural information. While the overwhelming dominance of the phylogenetic older chemical coding of relevant semantic information about the external world, which resembles the above-mentioned replication of genetic information, has been preserved in the majority of animals, humans accept and secondarily culturally code the epigenetic information almost exclusively with the help of two senses—sight and hearing. This potentially richer audiovisual basis, which undeniably contributed to the development of the theoretical constituents of spiritual culture, is much more freely attributed to the external world. Although its biotic carrier—the human brain—is also modified by the process of ontogenesis (the influence of the external environment, maturing, and learning, which shape its structure), the issue of recognizing the relevant cultural information and its value and validity, is not solved.[32]

Uncertainty and problematic obligation of cultural information at the level of an individual is influenced by another factor. If we leave out the question of its compatibility with the external world and the problem of its encoding, we find out that it enters the human mind as if *per se*, that is not only without its carrier but also without any external intermediary. Among people and between them and the world it is thus passed on only by the special resonance of subtle intermediary structures of both the external and the internal environment of the organism primarily by means of waves and photons. The specific electromagnetic interaction between the

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[31] The brain, as a biotic carrier of the sociocultural memory alone (that is without supporting theoretical reflection) recognizes, of course, only the part of the meaning, which could have been anticipated genetically, that is, which is closely connected with the essential living functions of the human organism and with its *a priori* setting to the offensive adaptive strategy.

[32] The issue of the specific audiovisual transfer of sociocultural information will stand out particularly when we realize that "Ninety-nine percent of the animals find their way by chemical trails laid over the surface, puffs of odour released into the air or water... Animals are masters of this chemical channel, where we are idiots. But we are geniuses of the audiovisual channel ... So we wait for the dawn, while they wait for the fall of darkness..." (Wilson 1992, 4).

carriers of the technical memory in our computers, though deterministic itself, does not reduce the biologically and culturally conditioned vagueness of sociocultural information either.[33]

Although the process of language coding of the sociocultural information cannot be analyzed in this text, I will briefly raise at least to a general problem of symbolism. At the beginning, that is without current conceptual ideals and theoretical interpretation constructions, human perception of the macroscopic order of reality had a significant biological flavour. Although it was syncretic (it coalesced with the projection of unreflected feelings, needs, and visions of the things themselves), it enabled objective discrimination of the properties and the structure of the external environment. The naming of the things and their replacement by symbols, which has probably been the most important cultural act, meant not only the possibility to manipulate with them by ideas, for example by means of verbal magic,[34] but increasingly also the possibility to manipulate them practically.[35]

Particularly the creation of symbols, which, according to Bertalanffy, "goes far beyond the biological advantage", resulted in the separation of the human internal and the external world. It meant a transition to an entirely new interpretative language, which was, in contrast to the "imperative" language of chemical signals, liberated, by its illustrative character, from instincts and strengthened the feeling of superiority of humans over nature. The more or less freely created essence of conceptual symbols, which had won its sovereignty, cultivated, on the one hand, human dissatisfaction with the natural status of the world, and, on the other hand, it definitely divided what had never been separated before: the world and its image in human mind.[36]

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[33] Interestingly, Dawkins, in his reductionistic thinking, does not distinguish between the different ways of replication of the genes and memes. He reminds that just as the genes are reproduced in the gene pool, the memes are reproduced in the meme pool, that is by imitating and by jumping from brain to brain (cf. Dawkins 1989, 192).

[34] A. Gehlen pointed out to this problem by the idea that the technical mastering of external natural forces was preceded by their fictitious mastering by the supernatural technique, that is magic. "Fascination with automation means for the technique pre-rational and extra-practical stimulus..." (Gehlen 1957, 15).

[35] It is not quite clear that the process of the mentioned manipulation with the world, inclusive of the intentional creation of technical constructions was significantly stimulated by the development of the depictional function of human interpretative language. Without a proper language it is not possible to communicate finely or to finely construct new ontic structures. Therefore we agree with the idea of S. Lem that without language it is impossible to construct even when the designer is impersonal (when for example natural biotic revolution is the designer) (cf. Lem 1995, 236).

[36] L. von Bertalanffy points to the essential meaning of symbolism in cultural evolution (cf. Bertalanffy 1967).

Symbolism thus actually disconnected sociocultural information and the human mind *from the world of things and chemical signals* and offered them a new degree of freedom within the implicit order of culture: a practical method of trial and error could be replaced by the rational method, that is by trial and error in conceptual symbols; causality could be completed by finality—purposefulness. The future goal was anticipated by nature—through blind genetic information, it could also be analogously anticipated also by culture—through human conscious epigenetic sociocultural information (naturally only in its ideal symbolic image). From the perspective we are tracing now, it is equally important that symbolism created prerequisites for artificial linguistic record, that is, it *created a new memory structure outside the human brain, not existing in nature.* This extended its natural ability to encode, accumulate and organize neural information. Not only objectified, shown, and verbalized intellectual visions but now also the visions recorded could become part of the general sociocultural information—"the flexible genome of culture".[37]

The ontic role of sociocultural information will become more understandable when we take into account what has already been said: that from the originally semantic natural information a relatively independent component of the sociocultural structural (theoretical) and semantic (communicative) information was singled out. With regard to the necessity to transform the current ecologically threatened culture, there is a crucial finding that every piece of generally shared cultural information, predominantly semantic as well as predominantly structural, can have a sufficient ontically creative strength and can be fully socioculturally constitutive. Let us recall that the evolutionary cultural creativity had not begun out of thin air, from some initial zero point, but that it modified what natural evolution had produced: with respect to a large impact of the integrating strength of human emotions and ideas, culture could adjust a variety of the results of the earthly evolutionary process, it could regroup and shape the naturally constituted structures. The biotically predetermined offensive adaptive strategy of humans, which has also become the first dominant strategy of the cultural system, was also possible without the theoretical vision of the world as a whole. The adequacy of human activities and artefacts to the Earth or their functional compatibility with it, did not have to rely on any general ontological theory, it did not have to be regulated morally or politically, but it had been ensured by nature itself in advance: largely by the *a priori* genetic human memory.[38]

Human acting against nature was possible and efficient also when it relied on the predominance of the figurative and vague semantic information and on a partial

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[37] According to Bertalanffy, symbolism is what distinguishes humans from other living species (cf. Bertalanffy 1967).

[38] The metaphorical formulation of S. Lem is remarkable: "In this special sense one can declare that the organism passes the sentences *a priori* by embryonic cells: their overwhelming majority appears to be true..." (Lem 1995, 230).

and distorted vision of reality. This finding agrees with the fact pointed out by J. D. Bernal (1954) that the history of the development of the particular areas of technology forms an almost reverse order to the analogous regions of the historical development of science. In short, culture had grown according to its own information, not very adequate to nature from the very beginning, to the detriment of the complex and fine structures of natural ecosystems and to the detriment of the irreplaceable variety of the biosphere.

In the stage of rapid scientific and technical progress, when, in addition to the structurally vague semantic information, the science-based structural information (that is much more certain and potentially verifiable) is also able to assert itself, the determining culturally ontically forming information remains primarily that which, due to its compatibility with the "situation", can have a wide social support and which cannot be strictly theoretical: simple theses of practical everyday policy, which respect the "ordinary" civic attitudes, generally shared opinions, values, illusions and feelings. Although thanks to special scientific structural information cultural abiotic structures and technologies harmless to nature are arising for the first time, with regard to the consumption- and market economy-oriented technical society, human self-preservation "...appears against this social background as something which does not have a topical meaning and can be put off until the future" (Král 1998, 121).

In quest of the new cultural strategy, the greatest barrier will evidently be the fact that the natural memory structure of the average human brain remains the physiological basis of both forms—semantic and structural—of the constitutive sociocultural information. It is biologically limited, approximate and non-linking to the individual nervous memory. This *a posteriori* human memory was, as we know, once set by the *priori genetic memory to offensive adaptation.* It is thus almost certain that the rapid growth of the theoretical knowledge (structural sociocultural information), achieved in contemporary society by highly specialized activities of scientists, will never be able to spread only horizontally and to influence directly the average human mind.

However, the problem is still more complicated. It does not consist only in the adequate content of ontically constitutive cultural information. It also lies in the fact that the more adequate sociocultural information should be accepted by the cultural system and should be able to play an ontically constitutive role in it.

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