

ARBITRARINESS IN NATURE: SYNERGETICS AND EVOLUTIONARY LAWS OF PROHIBITION

HERMANN HAKEN and HELENA KNYAZEVA

SUMMARY. The philosophical consequences of synergetics, the interdisciplinary theory of evolution and self-organization of complex systems, are being drawn in the paper. The idea of discreteness of evolutionary paths is in the focus of attention. Although the future is open, and there are many alternative evolutionary paths for complex systems, not any arbitrary (either conceivable or desirable) evolutionary path is feasible in a given system. There are discrete spectra of possible evolutionary paths which are determined exclusively by inner properties of the corresponding systems. Synergetics allows us to reveal general laws of self-organization and, therefore, certain limits of arbitrariness of nature in choosing possible paths of evolution as well as in constructing of a complex evolutionary whole. A comparative analysis between the modern synergetic notions and a few ideas of the Western philosophy (F. Nietzsche, N. Hartmann, M. Heidegger) and of the Eastern teachings (Taoism, Buddhism) is made.

Key words: complex systems, evolution, nonlinearity, pre-determination, self-organization, soft management, structure-attractors, synergetics

1. INTRODUCTION. SYNERGETICS AS A MODERN MULTIDISCIPLINARY RESEARCH PROGRAM

Synergetics can be considered as one of the modern, most promising research programs. It is oriented towards the search for common patterns of evolution and self-organization of complex systems of any kind, regardless of the concrete nature of their elements or subsystems. Synergetics is an interdisciplinary, or multidisciplinary, theory by its nature.

The theory might be used as a general methodological tool. The non-linear evolutionary models developed in synergetics can be applied to the understanding of human cognitive and cultural activities as well as to the management of complex social processes. Due to synergetics some bridges between the natural sciences and the humanities may be constructed, and some basis for cross-disciplinary communication may be elaborated.



The development of synergetics entails deep changes in the conceptual net through which we comprehend the world. A new synergetic worldview is in the process of formation now. It means a radical shift of paradigm, a conceptual transition from being to becoming, from stability to sustainability, from images of order to chaos generating new ordered evolving structures, from self-maintaining systems to fast evolution through a nonlinear positive feedback, from evolution to co-evolution, reciprocal evolution of different complex systems. The new synergetic style of thinking is evolutionary, nonlinear and holistic. This is a modern stage of development within the traditions of cybernetics and system-structural analysis. However, many elements of the latter have undergone important changes since their appearance.

Synergetics is a multi-faceted phenomenon in modern science. It has a number of different dimensions. We can consider synergetics in its philosophical dimension, i.e. to draw some philosophical consequences from the laws of evolution and self-organization discovered by synergetics. The epistemological dimension of synergetics constitutes the synergetics of cognition, the application of evolutionary nonlinear, synergetic models to the understanding of human cognitive and creative processes. It is an approach within the frames of evolutionary epistemology. Its social dimension means the studies in the constructive principles of co-evolution and self-organization of complex socionatural, socioeconomic and geopolitical structures. We could speak also about a futurological dimension of the theory, i.e. synergetics as a new methodological foundation for studies of the future, for construction of soft lines of the future.

Synergetics itself comes very close to traditional philosophical problems.

- What is new? Is there in principle something new under the sun? Or every event is simply something déjà vu, a repetition of a certain event that already happened. How can the known paradox of 'new' be solved?
- What is time? How is the past related to the present as well as the future to the present? Can the use of teleological thinking be justified? And if yes, to what extent?
- What are connections between the potential and the actual (the feasible and in principle the infeasible), and between the accidental and the necessary (the random and the due) in the world?
- What is whole? How is the whole related to the parts? What are the rules of construction of a complex evolutionary whole, complex structures?

Although the philosophical dilemmas themselves are generally considered as ultimately insoluble ('eternal'), synergetics provides some additional arguments in favor of a certain solution.

The aim of this paper is to develop a very simple, but highly astonishing idea. Although the future is open, and there are a number of possible evolutionary ways for a complex system, not any arbitrary (either conceivable or desirable) evolutionary way is feasible in a given system. Only a definite set of possible evolutionary ways, evolutionary structure-attractors is available and feasible for implementation in the system. Only a discrete spectrum of evolutionary ways is 'allowed'. The word "allowed" means here 'allowed' by a system itself, by the inner properties of the system. To put it in other words, the spectrum of evolutionary ways into the future is not a continuous one, it is discrete. Therefore, there is no continuous space for human choice: possibilities of human choice are restricted in form of a discrete set of possible actions.

The research results of two synergetic scientific schools are used and presented in this paper: the scientific school at the Institute for Theoretical Physics and Synergetics (University of Stuttgart) and the Moscow school at the Keldysh Institute of Applied Mathematics and the Institute of Philosophy (both of the Russian Academy of Sciences). Some of the results, first of all, the idea of evolutionary structure-attractors of complex systems, have profound philosophical consequences.

The idea of structure-attractors is connected with the notion of reduction of complexity. The complex evolutionary dynamics of multicomponent systems can be described by just a few variables, the so called order parameters (Haken 1977, 1988). The order parameters allow us to essentially reduce the primary complicated behavior of an open nonlinear system. They 'enslave' the movement of microscopic parts and allow the system to find one of its own structures.

It is worthwhile to look a little bit more into the relationship between the order parameters and the parts that are enslaved by the former. As it turns out, the individual parts of a system generate the order parameters that in turn determine the behavior of the individual parts. This is the principle of circular causality. It can also be expressed in quite another term: namely the order parameters represent a consensus finding among the individual parts of a system, to draw an anthropomorphic picture. Thus, the few order parameters and the few possibilities they have in accepting their individual states reflect the fact that in complex systems only few definite structures that so-to-speak are self-consistent with respect to the elements are possible. Or to put it differently, even if some configurations are generated

artificially from the outside only few of them are really viable. This holds for any systems, even for societies.

According to the models developed by S.P. Kurdyumov and his collaborators (Keldysh Institute of Applied Mathematics in Moscow), the radical reduction of complexity takes place due to an exit of the evolutionary process to an asymptotic stage. The asymptotes are much more simple than the complicated, chaotic, unstable course of intermediate processes in open nonlinear systems (Kurdyumov, 1990; Knyazeva et al., 1994).

What are limits of arbitrariness of nature? How open is the future? What are evolutionary prohibition rules which can be derived from synergetics? What philosophical implications does the new synergetic knowledge have? How strong are these synergetic prohibition rules? Are there ways to change the sets of possibilities of further evolution, or to put it differently, to somehow transform a field of possible evolutionary ways?

2. SPECTRA OF POSSIBLE EVOLUTIONARY PATHS

How did the idea of spectra of evolutionary structure-attractors arise? The synergetic models of burning and heat conduction (diffusion) processes are the most widely used models claiming to be capable to explain many paradoxical processes of self-organization. The latter are mainly connected with localized (despite heat conduction) sources of burning (chemical reactions): the dissipative structures are arising on an active (burning) medium.

The scholars of the Keldysh Institute of Applied Mathematics and the Institute of Mathematical Modeling (the Russian Academy of Sciences) manage to discover mechanisms of localization, structure-formation in open nonlinear media (in open nonlinear systems). In relatively simple mathematical and computational models a result of fundamental importance has been obtained: a continuous open nonlinear medium potentially contains in itself different kinds of localization processes (different kinds of structures). A medium is a united source that acts as a carrier of different forms of future organization, as a field of different evolutionary paths (Achromeeva et al., 1989; Kurdyumov, 1990; Samarskii et al., 1995).

Structure (or organization) is not interpreted here as a stationary one. It is a process localized in certain regions of a continuous open nonlinear medium. The process has a certain geometry and is capable to develop, to reconstruct and to move in the medium. In other words, the structure is a spot of organization wandering inside the medium. An open nonlinear medium (system) covers itself by organization spots.

An internal mechanism of the structures generation and their evolution (reconstruction, integration and disintegration) is a competition, an interplay between two opposite factors in a medium. One of them is the factor which dissipates, scatters about heterogeneities in the medium; it can be of various nature: diffusion, dispersion, hydrodynamics, etc. For example, it can be diffusion of neutrons, or diffusion (dissemination) of knowledge, or diffusion (spreading) of infectious diseases. The other factor is a work of a nonlinear source that can be also of different kinds. The source (of energy, information or infection) creates heterogeneities in the continuous medium. It can be an active medium in the nuclear reactor which generates an avalanche flow of neutrons, or it can be a source of knowledge or infectious diseases.

Thus, the idea of a spectrum of evolutionary structure-attractors can be developed and lead to some more concrete consequences.

- There are a number of types of possible structure-attractors, i.e. evolutionary pathways, even for a relatively simple open nonlinear medium (system). A whole 'zoo' of structures of self-organization, that is a set of rather exotic structures, can be contained even in a relatively simple medium. So much the more it concerns such complex systems as a human brain or society.

Investigations of the burning processes in a multidimensional case shows that the burning processes on an open nonlinear medium can be localized in form of a circle, a star, a cross, etc. In order to initiate the burning in form of such complex structures containing some different maxima within the area of localization, we have to distribute an initial excitation of temperature in a specific way. We have to 'prick' the medium in certain places. In a multidimensional case, all the Plato's right polyhedra, i.e. 'perfect bodies' of nature, are included in the spectrum of possible localized structures (Knyazeva and Kurdyumov, 1994).

It has been shown that symmetry is a condition for meta-stable self-maintenance of a complex structure of burning (a structure with several maxima of temperature). Maxima of temperature have to be in equal conditions: at the equal distances from a center of symmetry of the complex structure. Besides, they have to be of the equal value: to develop in the same tempo, with the same moment of peaking. If one of these two conditions is broken, the complex structure will degenerate in a simpler structure (with one maximum) and with a lesser moment of peaking.

- The spectra of possible, 'allowed' structures correspond to sets of the eigenfunctions of the nonlinear equations describing the evolutionary processes in the complex system. The sets of eigenfunctions of the corres-

ponding nonlinear equations are mathematical representations of spectra of evolutionary structure-attractors.

- The spectra of evolutionary structure-attractors are determined exclusively by the own properties of a corresponding complex system (open nonlinear medium). They are its inner potentials, so to speak, a ‘tacit knowledge’ of the system itself.

A property of selectivity (availability of some inner aspirations) is characteristic even for inanimate nature. Nature chooses, builds on its own body only the structures which are in accordance with inner tendencies of self-organization.

The problem of obtaining accurate spectra of evolutionary structure-attractors of open nonlinear systems (media) has been solved so far only in particular cases. Hence, we are faced with a vast area to explore. In fact, it is a ‘super-problem’, close to that of W. Heisenberg in nuclear physics, when nonlinear equations are required to describe a medium which as a self-organizing system would yield stable states in form of a spectrum of elementary particles. He formulates the problem as follows:

Es wird in mathematischer Sprache ein grundlegendes Naturgesetz formuliert, eine ‘Weltformel’, wie es gelegentlich genannt wurde, dem alle Naturerscheinungen genügen müssen, das also gewissermaßen nur die Möglichkeit, die Existenz der Natur symbolisiert. Die einfachsten Lösungen dieser mathematischen Gleichung repräsentieren die verschiedenen Elementarteilchen, die genau in demselben Sinne Grundformen der Natur sind, wie Plato die regulären Körper der Mathematik, Würfel, Tetraeder usw., als die Grundformen der Natur aufgefaßt hat (Heisenberg 1971, 261).

It seems that synergetics can initiate more complex research problems to be investigated by scientists. For example, tasks of determining a spectrum of biological forms or a spectrum of possible evolutionary economical and geopolitical structures.

3. DISCRETE SETS OF STRUCTURES. THE IMAGE OF EVOLUTIONARY TREE

As a matter of fact, our world is structured in a discrete way. The ability to form spatial, temporal or spatio-temporal structures is one of the most striking features of self-organizing systems. There is a number of examples of discrete sets of structures in the natural as well as in the human world. Maybe, it is worthwhile to speak even about spectra of motions, locomotory gaits, human emotions and gestures. Synergetics can propose a quite unusual view of some well-known phenomena.

The evolution of biological species is often represented in form of an evolutionary tree. This is a visual demonstration of a field of branching

paths in evolution of animate nature. If a point of branching (bifurcation) is already passed, a certain 'choice' is already made, the other, alternative paths of evolution become to be closed; the process of evolution is irreversible. Moreover, there is a certain spread between the evolutionary branches representing neighboring biological species. Why is there, for example, only a wolf or a fox as certain biological species? Why is an intermediate creature impossible? Several intermediate creatures are conceivable, but they are not viable. Even if such a symbiotic creature might be born, it is – from the synergetic point of view – an unstable structure and undergoes very rapid decay.

The 'architecture' of animate nature is connected first of all with the motion of living creatures. It is a harmonic combination, a certain disposition of parts into a meta-stable evolutionary whole. Although there are many types of structures, or configurations, the 'architecture' is by no means arbitrary.

Let us take as an example locomotory gaits of quadrupeds. Horses, for instance, don't walk in an arbitrary way. Certain kinds of gaits, as we can say from a synergetic point of view – self-movement patterns, of horses had been found for a long time. These are pronk (jump), gallop (bound), trot, pace, and other gaits. In all these cases, the movements of horse's limbs are coordinated with each other in a very specific way. The pronk is the simplest pattern of movement: all four legs move together and in phase. A bound, or an idealized gallop, is the next simple movement pattern. A detailed description of the matter can be found in previous works (Haken, 1996).

Certain poses of the trunks of elephants or the tails of dogs can be found as well. The position of an elephant's trunk corresponds to one of possible behavioral states of the animal. The elephant's trunk constructed of many segments is straightened, when an elephant is calm and non-aggressive. The trunk is rolled in a logarithmic spiral, when the elephant is in a state of excitement. The trunk has a lyre-like form, if the elephant blows.

Six basic emotional states of a human being, namely pleasure (joy), sadness, anger, fear, surprise, disgust, have been distinguished by psychologists. These are, of course, a kind of pure, idealized emotional states, but real human emotions can be qualified as inclined to this or that of basic states. Highly correlated external and internal symptoms such as facial expressions, heart beats, blood pressure and so on determine these various emotional states of humans. It's worthwhile to study the states as behavioral patterns with respect to their control and order parameters. The central question will be to cast the concepts into a scientific form that includes pro-

cedures for quantifying them. An enormous amount of research work lies ahead for behavior and psychological science in the light of synergetics.

One can visualize the synergetic notion of discrete spectrum of evolutionary structure-attractors by using one of the most ancient images known to humanity - the image of the World Tree. The image is present in the mythology of practically every civilization, with many different variants: the Tree of Life, the Family Tree, the World Pillar, the Evolutionary Tree, the Tree of Cognition, etc. World trees are simply versions of a cosmic organizational model in which spatial opposites (top – bottom, heaven – subterranean realm) are integrated. Temporal distinctions are removed as well: the past, the present and the future are represented synchronously in, for example, the image of the family relations, or in the organization of the developed scientific school (teacher and generations of his pupils). That is, a whole discrete spectrum of possible evolutionary paths displays itself in the present.

The image of the Evolutionary Tree is being widely used in modern science in a rationalized form. We just have talked about the tree of species in evolutionary biology. Linguists make use of the image rather often. They build ramified schemes of origin and development of the Indo-European languages from a supposed common source: a parent language, or a proto-Indo-European language.

According to the schemes, sets of branches corresponding to the present time, i.e. the spectrum of modern languages, is obviously discrete, rather than continuous. There are French and Italian. Or there are German and Dutch. The significant differences between neighboring languages can hardly be covered by possible, existing or conceivable, dialects. The consideration of the dialects can make the spectrum more dense, but this spectrum will remain to be intermittent, discrete one. Besides, there is the phenomenon of mixture of different languages. But, as it was said by the Russian writer Alexander I. Griboyedov, the mixture of French and the language of Nizhnij Novgorod (that is a Russian language with some peculiarities) is *mauvais ton*. Such a mixture is by no means admissible.

4. EVOLUTIONARY LAWS OF PROHIBITION

The future states of complex systems escape our control and prediction. The future is open, not unequivocal. But at the same time, the spectra of purposes, ‘aims’ of development are available in nonlinear media. If we choose an arbitrary path of evolution, we have to be aware that the path may be not feasible in a given medium. Only a definite set of evolutionary paths, evolutionary structure-attractors can develop.

There are no arbitrary structures that can be self-maintained in a given nonlinear system. Only the structures being in accordance with the inner evolutionary trends of the system can arise. And nothing else but select meta-stable structures can be constructed in the system. These are a kind of *evolutionary laws of prohibition*. The knowledge of restrictions, of something that can not be in principle constructed in the given system, is already valuable knowledge for a human. He knows, for example, that it's impossible to invent a perpetuum mobile, to gather energy from nothing, therefore, he will not spend his time and efforts in vain.

It's well worth adding that the most fundamental laws of nature, such as, for example, laws of conservation, are being formulated in science namely as principles of prohibition. When we can discover laws of prohibition, we are probably reaching the deepest layers of reality.

The sense of "unallowed" evolutionary paths can be understood now. Some evolutionary structures which do not correspond to the own structures of the system will be simply unstable. They will quickly decay. As it was mentioned above, probable living creatures having intermediate place in the evolutionary tree of biological species are not viable.

Some consequences for the management activities can be drawn from the synergetic notions. They are as follows:

- The multiple future presupposes ways of a special soft management. It is a management by 'clever' and appropriate influences. Weak, but proper, i.e. resonant, efforts are of great efficiency. They have to conform to the inner possibilities of a system itself. Correct resonant actions can lead to the revelation of tremendous inner forces and abilities of a complex system, be it a human being or a social (cultural, scientific) community. Thus, synergetics rediscovers a principle well-known from the history of philosophy: small events can cause large results.

- The art of soft management consists in the ways of self-management and the self-control of complex systems. How to manage a complex system without rough management is the main problem. How can we push a system in a favorable evolutionary path with a small, resonant influence? How can we provide a system with a self-maintaining and sustainable development?

As a matter of fact, the synergetic notions are in accordance with the behavioral rules of Eastern people, first of all, with the principle of non-violence.

The Taoist school held that the rulers should go with natural law (the 'Tao'), governing as little as possible (Min 1993, 226).

- Some human actions are doomed to be unsuccessful. They fail because they are not in line with the inner trends of the complex system development. If they are not proper, they will surely be actions in vain.

Taking into account the general synergetic consideration we can explain quite naturally the historical (the past and probably future) failures of voluntaristic management of scientific, technical, and social progress. The unsuccessful and tragic social experiment to build socialism in Russia as well as in the whole geopolitical space of the former USSR can be mentioned here. A management is ineffective, if it attempts to construct those structures which are not adequate to the inner trends of the evolving system, figuratively speaking, which ‘violate’ reality. Man has either to look for ways of changing the own features of the given open nonlinear system or to give up the attempts ‘to force’ the system to develop in an inappropriate way.

- There must be a certain organization of action. It turns out that managing influence must not be energetic, but rightly topologically organized. Its topological configuration, symmetric ‘architecture’ is important, not the intensity of an influence. The resonant action is a spatially distributed action. It’s a kind of prick at the right places and at the right time.

A whole system of right body positions (asanas) and appropriate mental influences (mandalas, mantras, special labyrinths for primary relaxation of brain) was developed in detail in Eastern studies such as Buddhism and Yoga. All these direct and indirect influences “prick” the mental field in the topologically right way and, therefore, facilitate the appearance of the highest states of meditating consciousness.

Synergetics defines how it is possible to multiply reduce time and required efforts to generate, by a resonant influence, the desirable and, what is no less important, feasible structures in a complex system. The weak defeats the strong, the soft defeats the hard, the low defeats the loud, as Taoists put it. The new science of complexity allows to reveal a synergetic sense in the ancient notion.

5. THE IDEAS OF PRE-DETERMINATION IN THE GERMAN PHILOSOPHY (F. NIETZSCHE, N. HARTMANN, M. HEIDEGGER)

The notion of discrete spectra of evolutionary structure-attractors of complex systems demonstrates a special kind of determination and even pre-determination of lines of development. The set of structure-attractors is determined only by inner properties of a corresponding system. The system ‘chooses’, actualizes every time only one of possible paths of development. In certain simplified mathematical models, we can see all possible paths

into the future. In such a case we have a picture as if all possible paths, so to say paths of Tao, would be revealed from a bird's eye view.

Some astonishing correlations between the synergetic worldview and ideas of the German philosophers can be found. Let us consider as examples only a few ideas of F. Nietzsche, N. Hartmann and M. Heidegger.

A kind of philosophy of the future in a poetic form was developed by Friedrich Nietzsche. Chaos is an intrinsic element of his philosophy. It plays a role of a creative basis in all processes in the world. Chaos is described as a unity of potentials. He gives an image of the birth of something new, the becoming in chaos and through chaos.

Ich sage euch: man muß noch Chaos in sich haben, um einen tanzenden Stern gebären zu können. Ich sage euch: ihr habt noch Chaos in euch. (Nietzsche, 1955, 284).

A paradoxical idea of determination of processes from the future can be found in his aphorisms. The future is in a sense pre-given: the future determines the course of historical events.

Die Zukunft und das Fernste sei dir die Ursache deines Heute: in deinem Freunde sollst du den Übermenschen als deine Ursache lieben. (Nietzsche, 1955, 325).

Or we read in another place:

Wachet und horcht, ihr Einsamen! Von der Zukunft her kommen Winde mit heimlichem Flügelschlagen; und an feine Ohren ergeht gute Botschaft. (Nietzsche, 1955, 339).

From the synergetic point of view, only a spectrum of possible paths of a complex system is relatively pre-determined at present by the inner properties of the system. What path will be 'chosen' by the system at a next bifurcation point, is open, unknown beforehand. Synergetics can show 'horizons of the future', a range of possibilities of further development.

The question of a horizon of the possible (der 'Horizont' des Möglichen) was considered by Nicolai Hartmann as well. A whole ontology of layer organization of reality was developed by him. The classical philosophical problems of the possible and the actual, purposes of development, time and space have a special place in his philosophical system.

According to Hartmann, the future is open as a realm of possibilities. The possibilities split the reality in a number of possible worlds. Therefore, the future is connected with plurality of simultaneously open possibilities:

Versteht man es [das Mögliche] aber von der gegebenen konkreten Realsituation in bestimmter Gegenwart aus als das Zukünftige, so stößt man auf jene Pluralität gleichzeitig offenstehender „Möglichkeiten“, von denen stets nur eine zur Verwirklichung gelangt (Hartmann, 1966, 10).

The future exists already in the present, namely as something possible. Moreover, the future possesses the same hardness of the real as the present does: it is to the same extent real in its due time as the present is in its time.

Everything has its own time for actual realization. Hartmann developed a notion that the present is ‘loaded’ with the future. Or, it is charged with the future. This is his notion of „der Zukunftsgeladenheit des Gegenwärtigen“.

Die Vorstellung einer „Vielheit der Möglichkeiten“ beruht wesentlich auf dem Bedürfnis, das aktuell Gegenwärtige in möglichst enger Verbundenheit mit dem Zukünftigen zu sehen, es gleichsam als ein schicksalhaftes Schwangergehen des „Jetzt“ mit dem noch ungeborenen Geschehen zu verstehen. Diesem Bedürfnis, obgleich das Bild ein anthropomorphes ist, liegt eine Auffassung zugrunde, die etwas Unabweisbares hat. Man kann das, was sie meint, als die Zukunftsgeladenheit der Gegenwart bezeichnen (Hartmann, 1966, 234).

The present activity containing in itself choices between different possibilities is not a matter of pure chance. The activity is built in accordance with the future. Hartmann paid special attention to the structures of teleological thinking. Specific features of these structures are relations of determinations, of necessity between the future and the present. The future is determined by the present. The total determination of the later stage of development is already contained in its earlier stage. This notion is much more radical and doubtful than the previous ones. It was under critical consideration in the quoted book of Hartmann.

Sie [die waltende Determination] besteht vielmehr, bildlich gesprochen, in einem Strom von durchaus gleichbleibender Breite [Breite des Werdens] – oder wenigstens grundsätzlich gleichbleibender – in welchem jederzeit die totale Determination des späteren Stadiums im früheren enthalten ist. (Hartmann, 1966, 236–236).

The phenomenon of pre-determination was investigated by Martin Heidegger in quite another and peculiar form. He elaborated an integrated conception of time which contains a detailed description of different modes, or images, of time. The latter are modes of being of available reality („Seinsmodi des Daseins“). The future is something running ahead, a project. The past (some happened events) is something what is already and forever available in the world. It is the factual aspect of the world, neglected elements in the world. The present is a “being by”, or “being near”, characterized by a sense of doom. We are doomed to this very present, because it is totally determined by facts of the past and projects of future.

Zukunft, Gewesenheit, Gegenwart zeigen die phänomenalen Charaktere des „Auf-sich-zu“, des „Zurück auf“, des „Begegnenlassens von“ (Heidegger, 1986, 328–329).

There are extremely complicated relations between various modes of time. The future is connected with a return, a coming back to something already happened. At the same time future (the best and, maybe, the former) opens a possibility for the birth of the present. It releases the present from itself.

Die Gewesenheit entspricht der Zukunft, so zwar, daß die gewesene (besser gewesende) Zukunft die Gegenwart aus sich entläßt. Dies dergestalt als gewesend-gegenwärtigende Zukunft einheitliche Phänomen nennen wir die *Zeitlichkeit* (Heidegger, 1986, 326).

The phenomenon of „Zeitlichkeit“ can hardly be translated in other languages. It constitutes an original unity of existential structures and an initial sense of existence. It hastens its own future and wakes the present.

Die Zeitlichkeit „ist“ überhaupt kein *Seiendes*. Sie ist nicht, sondern *zeitigt* sich... Die ursprüngliche und eigentliche Zeitlichkeit zeitigt sich aus der eigentlichen Zukunft, so zwar, daß sie zukünftig gewesen allererst die Gegenwart weckt. Das *primäre Phänomen der ursprünglichen und eigentlichen Zeitlichkeit ist die Zukunft*. (Heidegger, 1986, 328–329).

As synergetics shows, there are only a few elements of pre-determination in evolutionary processes. The process of striving for an attractor, when a corresponding point of bifurcation is already passed, is pre-determined. The attractor may be an attracting chaos (a strange attractor) or a meta-stable structure (structure-attractor) in a complex system. The processes of evolution are determined in a sense, because they obey some laws of evolution including the evolutionary laws of prohibition, but they are not pre-determined. The harmony of evolving complex structures in the world is not all pre-established or pre-given. It is a post-established harmony, i.e. an emerging harmony in accordance with the laws of evolution.

6. THE FIELD OF TAO PATHS.

THE POTENTIAL AND UNREVEALED IN THE EASTERN WORLDVIEW

Synergetics being a product mostly of the Western science turns out to be very close to the Eastern worldview presented, first of all, in Taoism and Buddhism. The latter is closely connected with the hieroglyphic writing and can be characterized by integrity, in particular, by a non-dual principle of mental perception of opposites.

Synergetics taken in its philosophical consequences has a number of astonishing common features with the Eastern outlook on the world. There is here a whole, almost untouched, field of possible research.

The Eastern people comprehend the world much more through images, than through words and concepts. Synergetics is also not free from thinking in images, so to say, from construction of some thoughts-images. It reveals universal patterns of self-organizing structures. The patterns formation, or as it used to say in German ‘Strukturbildung und verschiedene Muster von Strukturbildung’, is the main task of synergetic investigation. Spiral structures or a net of rightly organized hexagonal cells are paradigmatic examples of self-organizing structures.

Tao is one of the main Eastern symbols. It is not so easy to visualize Tao. As it was described by Lao-Tzu, a human follows the Earth, the Earth follows the Heaven, the Heaven follows Tao, but Tao follows only itself. Everything in the world follows Tao, but it goes at the same time its own path with its own speed, everything lives in its own tempo-world. A bindweed spends one morning to follow its Tao, a pine-tree spends thousand years to follow it, but they go one and the same path.

Everybody has to follow his own path and to reveal his own potentials. This is a very democratic attitude in Taoism. The due and consecutive realization of the own path leads at the same time to fulfillment of the path of Tao. It's worthwhile to mention the multiple ways and the multiple speeds in our following of Tao. The used synergetic model of the multiple evolutionary paths of complex systems turns to have something common with the Eastern view.

Another astonishing oriental idea is the idea of the potential and the unrevealed. It was also presented in the teachings of ancient Greeks. An observable harmonious structure of the universe, Cosmos, arose from primordial Chaos, Being – from Non-Being, observable phenomena sprang up from an abyss unlimited in its potentials. Non-Being is a potential and an unrevealed, something without a certain form. It is an eternal, all-begetting and all devouring, basis of things. On the contrary, Being is something actual, revealed and already formed; it is a temporal and transient manifestation of Non-Being. According to "I Ching", Chinese "Book of Changes", situations as if would emerge from Non-Being and, obeying a strict rhythm of the world development and having exhausted themselves, return to Non-Being.

Although Non-Being is interpreted as a shapeless, it is as a matter of fact infinitely rich of forms, but still latent and incomplete, developing forms. Non-Being implicitly contains in itself everything, all possible forms for realization. Non-Being, the Emptiness, is devoid of any shape, but it harbors everything. The emptiness is a condition of the appearance of things. It allows them to find their nature. Non-Being is not yet open and formed Being, as if a fore-being, but not an after-being. It is a germ of life, not yet a tree or a fruit, but something already containing the potential of the tree or the fruit. Non-Being is something from which everything grows like from a seed of the universe.

The image of Non-Being coincides in some aspects with the synergetic understanding of an open nonlinear medium (a complex system) which implicitly conceals in itself all paths of evolution that are feasible for the medium (system). The potential and the unrevealed is, from the synergetic point of view, the availability of evolutionary structure-attractors. The me-

dium is a carrier of different forms of future organization. It is a carrier of a discrete spectrum of structure-attractors, or a set of potential final states.

7. THE AIM AND THE WHOLE.

DISCRETE WAYS OF THE CONSTRUCTION OF COMPLEX STRUCTURES

The striving for an evolutionary “aim” (for one of evolutionary structure-attractor) is closely connected with the construction of a whole, an integrated whole structure. The attainment of the “aim” means in a sense the appearance of an evolutionary whole.

Synergetics allows us to reveal laws of co-evolution of complex structures “of different ages”, i.e. structures being at different stages of evolution and having different rates (tempos) of evolution, as well as laws of ‘including’, building a simple structure into a more complex one (Knyazeva and Kurdyumov, 1994; Kurdyumov, 1990).

There are various, but not arbitrary, ways of integration of simple structures into the complex ones. Not any arbitrary evolutionary structure can be integrated in any other one and by no means in an arbitrary way. There is a restricted set of integration ways, i.e. discrete paths of construction of a complex evolutionary whole.

A certain degree of connection and overlapping of simple structures is very important when a process of integration takes place. There must be a certain topology, ‘architecture’ of overlapping. There must be a positive ‘feeling of measure’.

The integration of different evolutionary structures occurs according to their ‘architecture’, topology of organization as well as their speeds of development. The main principle of integration of parts into a complex whole can be formulated as follows: synthesis of relatively simple evolving structures into a more complex one occurs due to the establishment of a common tempo of their evolution. The fact of integration signifies that structures becoming parts of a whole acquire a common tempo of development. Structures fall into one tempo-world, begin to develop with the same speed. One can speak about a co-existence of ‘differently aged’ structures in the same tempo-world.

Besides, in the case of the right topology of integration (in the case of a certain degree of interaction of structures) a growing whole organization can accelerate its tempo of evolution.

8. MULTIPLE FUTURES IN SPITE OF EVOLUTIONARY BANS

Thus, only discrete spectra of evolutionary paths (structure-attractors) are feasible for implementation in the world. Only restricted sets of ways of integration into an evolutionary whole are 'allowed'. How open is, then, the future? Or, to put it differently, is it possible to make the evolutionary impossible possible?

To a certain extent, yes. Spectra of evolutionary paths can transform themselves due to the changes of the own properties of the corresponding complex systems. Owing to the transformation, new possibilities of further development can be opened.

The characteristics of the inner properties of a complex system enter as parameters in the corresponding nonlinear differential equation. If the characteristics change, the set of eigenfunctions of the equation changes too. To express this in a mental image, the field of possible evolutionary paths of a complex system into the future can rebuild itself – to this or that extent – depending upon the inner properties of the system.

The future is open and uncertain in our nonlinear world. As one sometimes expresses it now, it is a fuzzy future. The world is creative. An unexpected and often charming new appears in it. Synergetics reveals laws underlying the emergent phenomena. The science tries to connect different micro- and macro-levels of reality as well as different temporal moments on the axis of time.

ACKNOWLEDGMENT

One of the authors, Helena Knyazeva, wishes to thank the Alexander von Humboldt Foundation for the financial support of the research presented in the paper.

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Hermann Haken
Institute of Theoretical Physics and Synergetics
University of Stuttgart
Pfaffenwaldring 57/4
D-70569 Stuttgart
Germany

Helena Knyazeva
Institute of Philosophy
Russian Academy of Sciences
Volkhonka St. 14
119 842 Moscow, Russia.