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Helena Knyazeva

The Idea of Co-evolution

Towards a New Evolutionary Holism

The Evolutionary Whole

The main principle of holism – "the whole is more than the sum of its parts" – can be traced back to ancient philosophical studies. Although the term itself was coined by Jan Christiaan Smuts in 1926, the earliest formulations can already be found in Taoism, in the philosophy of Lao Tzu, as well as in Aristotle's *Metaphysics*. However, a complete and profound sense of the principle has only been revealed in such theories as Gestalt psychology (Kurt Koffka, Max Wertheimer and others), the general systems theory (Ludwig von Bertalanffy), and the theory of complexity (synergetics) as formulated by the Moscow school of synergetics (Sergey Pavlovich Kurdyumov), to name just a few.

Thinking in this direction, from the whole to the parts (subsystems), is quite unusual for classical science which, in its course of analysis, usually moves from distinct parts to the whole. In synergetics, according to Hermann Haken, order parameters determine how parts (subsystems) of complex systems behave.[1] A select few order parameters, as Haken says, encompass the complex behavior of diverse parts and, therefore, lead to enormously reducing the complexity in a description of a given system.

The classical principle of superposition is not valid in the non-linear world we live in, where the sum of partial solutions does not add up to the solution of an equation that would allow us to describe an entire system. The whole is not equal to the sum of its parts. Generally speaking, it is neither more nor less than the sum of parts. Rather, it is qualitatively different from the parts that it integrates. In addition, an emerging whole alters the parts. For instance, when a family is created, both a man and a woman who marry become different; new obligations and benefits follow from living together.

The co-evolution of different systems implies a transformation of all subsystems through different mechanisms of system coordination and correlation between them.

Thus, the modern theory of complexity reveals new principles of organization regarding the evolutionary whole and its parts as well as new principles on the formation of complex structures from simple ones. From this point of view, holism

1 Hermann Haken/Helena Knyazeva: "Arbitrariness in Nature: Synergetics and Evolutionary Laws of Prohibition", in: *Journal for General Philosophy of Science* 31 (2000) 31, pp. 57–73, here p. 59.

itself obtains an evolutionary character.[2] The emerging complex structure integrates structures from 'different periods', that is, structures at different stages of evolutionary development. The principles governing the integration of these structures from 'different periods' are gradually being discovered by researchers from the Moscow school of synergetics. The integration of relatively simple structures into a more and more complex one occurs by establishing a common rate of development in all unified parts (fragments, simple structures). Due to the formation of a united structure, structures of 'different periods' start to co-exist in one and the same tempo-world.[3]

The notion of evolutionary holism in itself includes an understanding of the emergent properties of the whole, of an integrated structure that forms in the course of self-organization and evolution. Self-organization and emergence are usually considered as conjoined notions. Emergence should not be understood in a simplistic way: it is not merely a matter of spontaneous and unpredictable appearances of new properties for the whole structure. If we focus on the unpredictability and incomprehensibility of the appearance of something new, we are only underlining the epistemological aspect of novelty. Emergence, as a creative potential, is rooted in reality and has an ontological basis. Emergence relates to the irreducibility of the properties of the whole (a system) to the properties of its parts (elements or subsystems). This irreducibility constitutes the difference between the highly organized to the less organized, of the complex to the simpler, of a higher order in the hierarchy to a lower one. Evolution consists of qualitative leaps, phase transitions, and emergent transformations, through which formerly unknown properties come into existence. Emergence is how novelty is born within the evolutionary process of nature and of society.

Co-evolution as an "Art of Living Together"

The German professor Hermann Haken, one of the founders of synergetics, understands synergetics as a study of interaction (*Lehre vom Zusammenwirken*), which strives to comprehend the main laws underlying the emergence of ordered, spatio-temporal structures out of chaos. The term "synergetics," coined by Haken, became widespread and the preferred name for a whole field of research dealing with complex systems. The Russian scientific community has had a specific interest in synergetics over the past two decades.

2 Here, the term "evolution" is considered from a non-traditional view. By evolution, I mean gradual changes, but also periods of instability and increases in chaos as well as periods of fast development with emergent events, which not only unroll and contribute to the growth of complexity, but which also impede it and lead to involution and dead-ends of development.

3 See E[lena] N. Knyazeva/S[ergey] P. Kurdyumov: *Osnovanija sinergeki. Režimy sobostreniem, samoorganizacija tempomiry* (The Foundations of Synergetics. Blow-up Regimes, Self-organization, Tempo-worlds), Sankt-Petersburg: Aletheia 2002.

One of the leading scholars in the field of synergetics in Russia was Sergey P. Kurdyumov (1928–2004), a specialist in mathematical physics.[4] We might well consider him a leader of the Russian scientific school of synergetics, which has its center at the Keldysh Institute of Applied Mathematics at the Russian Academy of Sciences in Moscow. The research has been focused on the analytical methods for finding solutions to complicated non-linear equations, such as differential equations on a specific heat conduction type with a non-linear source, as well as computer experiments involving evolutionary processes in open, non-linear media (systems).

Synergetics has a unique image in this context. It developed as a theory of non-stationary, localized, dissipative structures, a new type of ordered structures in systems with non-linear positive feedbacks. It has come to also involve theories on rapid evolutionary processes (so-called blow-up regimes) and the formation of localized structures, their transformation, co-evolution, synthesis and decay.

Significant results from the field of synergetics have also had profound philosophical importance. The idea of co-evolution was one of the most important ideas introduced by Kurdyumov. Whereas Haken developed synergetics on the basis of laser physics, the Moscow school relies mostly on the mathematical modeling of complex structures, their construction, and their co-evolution in open, dissipative media. While a paradigmatic example in Haken's synergetics was the formation of coherent radiation from a laser, the physical basis of mathematical modeling for the evolution of complex structures are self-organization processes in plasma. One of Kurdyumov's great contributions was the discovery of the *constructive principles of co-evolution of complex systems* and capabilities of *mastering time in order to construct a desirable future*.[5]

Kurdyumov understood co-evolution in a broader sense than its ecological meaning as simply the co-evolution of humankind and nature. Co-evolution more generally involves the joint and concordant development of complex structures at different stages of evolution and which have varying degrees of complexity.

Why did Kurdyumov label the principles of co-evolution discovered by synergetics 'constructive'? Firstly, they can be used for effective management, for a strategic vision of the future and for long-term planning, for the elaboration of rational, national and state policies in a globalized world. Secondly, the synergetic principles of co-evolution have substantial consequences. They are oriented towards an understanding of the remote future which is impossible to predict using traditional methods. A deep understanding of the synergetic principles of co-evo-

4 I consider myself fortunate to have collaborated closely with Kurdymov, a teacher of mine, for almost two decades. I have done my research at the Institute of Philosophy of the Russian Academy of Sciences. In the 1990s, Sergey P. Kurdyumov was the Director of the Keldysh Institute of Applied Mathematics of the Russian Academy of Sciences. These two institutes have close scientific connections.

5 See Helena Knyazeva/Sergey P. Kurdyumov: "Nonlinear Synthesis and Co-evolution of Complex Systems", in: *World Futures* 57 (2001), pp. 239–261. For further materials see also www.spkurdyumov.ru (last access March 2015).

lution, of the non-linear synthesis of parts into a sustainable, evolutionary whole can and should underline the modern "art of living together." These principles also reinforce tolerance and the preservation of diversity in globalizing communities.[6]

Present-day managerial practice needs to exercise a holistic rather than an analytical view. Along with the slogan of our times, "Think globally, act locally," we might add that in order to comprehend the slightest alteration in existing management systems , one needs non-traditional knowledge of sociosynergetics, i.e. on understanding the laws of co-evolution and self-organization of complex social, economic and geopolitical systems. This knowledge is of inestimable significance as it provides the worldview necessary to understand the course of evolutionary processes in complex systems to which human and social systems belong *par excellence*.[7]

In order to carry out even the slightest reforms in social management, it is necessary to change mentalities. The very mode of thinking should be global, non-linear, holistic, concerned with solidarity, and based on an understanding of the constructive principles of co-evolution, i.e., an understanding of the rules on how 'to live together' and develop together in a sustainable way. In other words, to think globally means thinking integrally and holistically in order to grasp how structures at different levels develop according to varying rates and integrate into a united, harmonious evolutionary whole.[8]

The complexity of a structure is connected to its coherence, which here refers to coordinating the 'life'-tempos of structures by means of diffusive and disparate processes that constitute macroscopic manifestations of chaos. In order to build a complex organization, it is necessary to coherently join subsystems and to synchronize the rates of evolution. As a result of this unification, the structures fall into one tempo-world, acquiring one and the same peak moment; that is to say, they start to co-exist in the same tempo-world.[9]

To create a complex structure, it is necessary to know how to unify structures 'of different periods', i.e., structures at diverse evolutionary stages and rates (tempos). It is necessary to know how to include elements of 'memory', e.g., the biological memory of DNA or the memory of culture through traditions. In as much as structure-attractors, which characterize the developed, steady evolutionary stages of structures in the non-linear world, can be described by invariant group solutions, the spatial and temporal properties of structure-processes appear to be tightly bound. The structure-attractors of evolution are characterized by invariance

6 See E[lena] N. Knyazeva/S[ergey] P. Kurdyumov: *Sinergetika. Nelinejnost' vremeni I landšafty koėvolucii* (Synergetics. Non-linearity of Time and Landscapes of Co-evolution), Moscow: URSS Publishers ^{2}2011.

7 See V[ladimir] A. Belavin/E[elena] N. Knyazeva /S[ergey] P[avlovich] Kurdyumov: "Blow-up and Laws of Coevolution of Complex Systems", in: *Phystech Journal* 3 (1997) 1, pp. 107–113.

8 See Helena Knyazeva: "The Synergetic Principles of Nonlinear Thinking", in: *World Futures* 54 (1999) 2, pp. 163–181.

9 See Helena Knyazeva/Sergey P. Kurdyumov: "Nonlinear Synthesis and Co-evolution of Complex Systems", in: *World Futures* 57 (2001), pp. 239–261.

whereby space and time are not free but intimately connected with each other. The dynamics necessary for the development of a complex structure demand a coordinated development of substructures from 'different periods' (i.e., which share the same peak moment[10]).

Generally, this leads to the breakdown of spatial symmetry. The insertion of 'memory' (of elements of the past) further signifies this breakdown of spatial symmetry.

Different structures can be unified but not arbitrarily. The degree of connection between the structures to be integrated as well as their stages of development are not arbitrary either. There are various but not arbitrary paths that lead to the unification of structures into integral ones. The ways of constructing a complex co-evolutionary whole are ultimately restricted.

The selectivity (the quantum character) of integration is connected to the requirement of the parts and the whole having to exist in the same tempo-world, i.e., the development of the parts at one and the same peak moment. This is the physical basis of quantification by integration for complex evolutionary structures. If joinable structures have peak moments that are even slightly different from each other, they become incomparable.

Thus, the synthesis of relatively simple evolutionary structures into a whole complex structure occurs by the establishment of a shared rate of evolution between all unified parts (fragments, simple structures). The intensity of the processes in various fragments of the complex structure (for example, in the social medium, levels of economic development, quality of life, access to information, etc., in different countries) can be diverse. The fact of integration reveals that the structures becoming parts of the whole have acquired a common rate of development.

An integrated complex structure only arises if there is a certain degree of overlap among the simple structures. There must be a topology or an 'architecture' of superposition. A constructive 'sense of proportion' must be observed. If the area of overlap is not sufficient, the structures will develop independently, since they do not 'feel' each other and will continue to live in different tempo-worlds. However, if the overlap includes large fragments of structures, the structures will flow together very fast and 'degenerate' into one rapidly developing structure straight away.

Acceleration of Development as a Great Gain from Co-evolution

If a complex structure is organized from more simple ones in the right topological way (that is, if the specific degrees of interaction and overlapping of substructures are in order as well as the proper symmetry in the 'architecture' of an emerging structure), the united structure finds itself at a higher level of hierarchical organiza-

10 The peak moment is a moment of maximum development in a complex structure. It is characteristic of blow-up regimes, which have a long quasi-stationary stage and then a stage of ultra-rapid increase within processes in open non-linear media.

tion. Thereby, the rate of development during the integration of parts into a complex structure accelerates. The quickly developing structures pull the slowly developing structures towards their more rapid tempo. In cases of appropriate unification, the ratio between more developed structures' maximum rates and those of less developed ones remains constant, i.e., small, underdeveloped structures do not fall into another tempo-world; they do not become a mere background for the development of structures with larger rates of development.

The path to unity and integration of different parts into whole structures is neither steady, permanent, nor monodirectional. The evolutionary ascent towards more complex forms and structures passes through a number of cycles of decay and integration, of peeling off from the whole and inclusion into it, of deceleration and acceleration of processes.

The theory of self-organization implies that any open system with strong non-linearity is most likely to pulsate. They have natural cycles of development: The differentiation of parts alternates with their integration, scattering with regrouping, and the weakening of bonds with their strengthening. The world seems to move towards a universal unity, albeit forward but not monotonously, instead forward through fluctuations and pulsations. The stages of decay, even if partial, are followed by stages of increasingly powerful unification.

The cycles of increasing and decreasing intensity of processes as well as the decay and unifications of parts indicate a regularity in non-linear processes; the cycles are determined by the very nature of non-linear processes. At the moment of maximum accretion or the height of development (at the peak of its processes), any complex structure is subject to inner instability caused by small perturbations and is thus under the threat of deteriorating.

The history of humankind is full of world empires that increased in size and strength to their maximum extent, and in the end they collapsed, sometimes disappearing completely, barely leaving a trace. But if the beginning of a geopolitical system's downfall is carefully observed, it is reasonable to pose the following question from the synergetic point of view: Does the system possess a sufficient degree of non-linearity so as to turn the evolutionary processes back, to switch them to another regime of bond renewal, to achieve the attenuation of processes in the central domain along with their stirring at the periphery of the structure? If the non-linearity is not sufficient, the former intensive processes may simply be extinguished and come to naught.

Thus, the fundamental behavioral principle of complex non-linear systems is based on the periodical alternation of stages of evolution and involution, of unfolding and folding, of procedural intensity and fading, and of integration and disintegration. Here, there are profound analogies between the historical accounts of the downfall of civilizations and the break-up of great world empires to Nikolai D. Kondratiev's cycles, John K. Galbraith's oscillatory regimes, and Lev N. Gumilyov's ethnogenetic rhythms.

During the initial formation stage of a complex structure, its correct topological organization is of great importance. When the process of integration occurs, the structures are not simply put together; they do not simply become parts of the whole in some unaltered, undistorted form. They are transformed; they form levels on top of each other and intersect. At the same time some of parts fall away. As physicists say in such cases, overlapping occurs with a net energy loss. This signifies that unifying a system leads to saving energy and to a decrease in material expenses and human effort.

When the proper topological, structural organization is in place in an evolutionary structure, its peak moment is not far off. The whole develops faster than its integral parts. It is more profitable to develop together, since the joint, co-evolutionary development is connected with economizing material (in particular, material energetic and psychical resources). With every new way of proper topological integration, successive layers of hierarchical organization appear more rapidly in the whole as well as in its integral parts. Therefore, the evolutionary path towards increasingly complex organizations of structures is, to a certain extent, pre-determined.

Co-evolution is *per se* "the art of living together."[11] To follow the rules of co-evolution implies constructing a preferable and sustainable future. An important goal thus takes shape: To define order parameters that determine a corridor of sustainable co-evolution within the evolution of states. General rules regarding the co-evolution of complex social, economic, and geopolitical structures on different scales (e.g., national, international, global) arise from analyzing mathematical models. These rules can be summarized in terms of these key notions:

a) A *common rate* of development is the principal indicator of complex structures connecting in a single whole;
b) *Non-uniqueness and involuntariness* characterize the assembly of a whole from parts;
c) Structural parts do not enter the whole in an invariable form; they *are transformed and become reformed* in accordance with the peculiarities of the emerging evolutionary whole;
d) For the assembly of a new complex structure, for the re-crystallization of a medium, one needs to create a situation "*on the edge of chaos*,"[12] in which small fluctuations are able to initiate a phase transition, which casts a system into another state and sets a different course for the morphogenetic process, another way of assembling the complex whole;[13]
e) A *proper topology* of the combination of structures is of great importance when making a dynamically evolving integral structure;
f) In case of the right, resonant unification of complex structures into the whole, a united super complex structure begins to develop at a higher rate.

11 See Helena Knyazeva: "Co-evolution as the Art to Live Together", in: *Indian Science Cruiser* 22 (2008) 1, pp. 22–27.

12 See Stuart Kauffman: *At Home in the Universe. The Search for Laws of Self-organization and Complexity,* London: Viking 1995.

13 "The very nature of co-evolution is to attain the edge of chaos." Kauffman: *At Home in the Universe* (note 12), p. 29.

Co-evolution is not simply an adjustment process between the parts among each other that then ends in forming a complex whole, rather it is a product of active participation, a synergism between a cognizing and constructing subject and the medium surrounding it. Co-evolution can also connect large organizations of humans and single individuals. It helps us understand how all things are connected with each other, even the mysterious connection between the past, present and future.

A Human Singularity of Co-evolution

From the synergetic point of view, these are the order parameters that determine the behavior of the parts of a complex system. Essentially, they allow us to reduce the complexity of description of the system under consideration and to describe it in a relatively simple way.

The synergetic models elaborated by Haken include the notion of order parameters, the slaving principle, and the principle of circular causality. In Haken's models, the individual parts of a system generate the order parameters that in turn determine the behavior of the individual parts. The behavior of parts is subordinate to these parameters, i.e., it is enslaved by them. To put it in anthropomorphic terms, the order parameters represent consensus building among individuals. Thus, just a few order parameters and the limited possibilities they have in affecting their individual states reflect how complex systems are confined to a handful of definite structures that are self-consistent with respect to the elements. Moreover, even if some parameters are generated artificially from the outside, they are rarely viable. This holds true for all systems, including societies.[14]

The chains of circular causality in order parameters thus pertain to:

– a way of cognition of complex systems;
– a way of building a complex organization;
– a way of embedding an individual part (for example, a man in society) in the whole, in an interactive net of communication and actions.

The order parameters determine not only the behavior of individual parts (the slaving principle), but beyond that every individual part contributes to shaping the order parameters as dynamic characteristics of a system. Moreover, in states of instability (near a point of bifurcation or a moment of blowing-up), the behavior of an individual part may become essential for the whole system and may be decisive in the formation of a new collective pattern of behavior.

It is important to understand that the formation of a whole is connected to the modification and deformation of parts, as they enter another medium in which other rules of behavior are valid. In addition, when the parts are undergoing

14 See Hermann Haken/Helena Knyazeva: "Arbitrariness in Nature. Synergetics and Evolutionary Laws of Prohibition", in: *Journal for General Philosophy of Science* 31 (2000) 1, pp. 57–73.

change, the whole can *awaken* new unusual, unprecedented properties in any individual part or in a variety of parts.

In precisely this respect, we may speak about the human *singularity* in co-evolutionary processes. In the mathematical sense, singularity signifies the point at which the derivative of a function becomes zero or, more important for us regarding the thermodynamics of blow-up regimes, when an infinite value of the function is reached, i.e., the function's curve changes in a qualitative way (for instance, in the case of a return point, a knot point, a break point, an asymptotic point, etc.). In the physical sense, it is a moment of instability, of transition, of rebuilding the course of the evolutionary process. In these moments of instability, a person, as an active subject in the construction of the world, can play a decisive role in defining the channel along which the evolutionary process will run. That path extends in accordance with a range of structure-attractors in a given medium and with the subject's own values and preferences.

The emergent properties of structural forms are connected to the non-linearity that characterizes the development of complex systems. This non-linearity further indicates the non-uniqueness of an evolutionary path as well as the potential for qualitative breaks, phase transitions, situations 'at the edge of chaos' when fluctuations can cast a system into another state and lead to the formation of new structures.

Complex systems are organized hierarchically. A part can itself be a whole if it, too, consists of smaller parts on underlying levels. *A part can be more complex than a whole* (its behavior, its spectrum of possible forms) if it has a higher exponent of non-linearity than the whole. A part of a whole can entail high complexity. This holds true particularly for a person in a society. A person is more complex than a social group or society since its non-linearity is higher. The strong non-linearity signifies that the corresponding structural form possesses a more complex range of form-structures and of possible regimes of development.

To Manage Co-evolutionary Complexity Means to Manage Time

Complexity is the unity of plural and diverse elements. According to Edgar Morin, who discusses this problem in its philosophical context, complexity is "unitas multiplex", i.e., both "unity of diversity" and "unity in diversity."[15]

According to the models of non-linear dynamics and the evolution of open dissipative structures elaborated by the Moscow school of synergetics, the complexity of structures and of their behavior is conditioned, first of all, by their *rates of evolution*. The rate of evolution in open non-linear systems is a central characteristic in exploring complexity.

15 Edgar Morin: *La Méthode*, Vol. 1: *La Nature de la Nature*, Paris: Editions du Seuil 1977, p. 147.

Some concrete examples help to explain this concept:

a) The very fast, avalanche-like processes in blow-up regimes demonstrate the effect of localization, i.e., the structure formation and the appearance of extremely complicated structures;
b) When periodical alternation takes place, the change in the rate of evolution as well as the general character of the processes at work serve as a basis for the self-maintenance of complex structures;
c) The tempo of evolution indicates the degree of a structure's integration as it develops at different speeds in a whole complex structure;
d) By synchronizing the tempos of evolution between different complex structures, we might contribute to co-evolution and more sustainable development in the world.

To manage time, or, more specifically, to master time is to know how to unify complex structures in an effective way. By creating a shared tempo-world, we can accelerate the development of a produced whole and its constituent parts. The path of co-evolution is a mutually beneficial path into the future.

Co-evolution is "the art of living in one tempo-world" while not curtailing diversity but maintaining and developing it on the level of elements as well as separate subsystems. In a self-organizing society, in a plural and united world, it is necessary to cultivate a feeling of responsibility for the whole in each nation and each individual.

Constructing a Desirable Future

The field of future studies examines modern forecasting under the following rubrics: a) the image of the future, b) alternative possible futures, c) creating the future rather than predicting it. A future-oriented vision of the world is based on solidarity with the future. We should not wait for gifts from the future but should rather work to build a desirable and better future.

Such efforts require effective management that should be soft, non-linear, and strategic (i.e., oriented towards the attainment of long-term goals and the active construction of a better future). It should also include social and economic risk management, such as diagnostics of social risks, estimations and justifications for allowable risks, and prognostication of the consequences of venturesome decisions.

Using relatively simple mathematical and computational models, it has been possible to show that a continuous non-linear medium potentially contains different kinds of localization processes (different kinds of structures), a fundamental claim in this research area. A medium is a unified source that acts as a carrier of different forms of future organization and as a field for different evolutionary paths.

Complex systems have discrete sets of evolutionary paths into the future,[16] and yet, the future states of complex systems escape our control and prediction. The

16 See Knyazeva: "Synergetic Principles of Nonlinear Thinking" (note 8), pp. 163–181.

future is open, not unequivocal. Yet, at the same time, there is a finite spectrum of 'purposes' or 'aims' of development available in any given open non-linear medium. When we choose a path of evolution, we have to be aware that this particular path may not be feasible in a different medium. Only a certain set of evolutionary pathways are open in a given medium, and only certain kinds of structures can emerge along a given path.

In order to successfully contribute to the construction and management of our modern, complex, globalized world and incorporate oneself properly into co-evolutionary processes, one should know how to:

a) Make robust decisions under deeply uncertain conditions shaped by the increasing complexity of social processes. To achieve this, an intellectual alliance (i.e., intellectual synergy) between predictions, production of innovations and entrepreneurial (managerial) activity is needed;
b) Think globally and participate actively and interactively in a way that is adequate to the situation. This aspect is known as the principle of situatedness of action;
c) Create a coherent and mutually concordant world that matches one's own cognitive and constructive capacities, and the potential of a specific medium;
d) Be in synergism with a medium, with an organization or enterprise under our managerial control. This is the principle of non-linear feedbacks as established between a subject and the medium of his/her activity.

It is important to understand that we are not merely external observers, but also participants in this historical adventure. We are part of the trends of social development and, thus, should not remain passive. We have no right to simply wait and see what will happen next and must instead assume our roles as creators of desirable futures. The Hungarian-born research engineer Dennis Gábor says, "The future cannot be predicted, but futures can be invented."[17] This research-oriented attitude makes sense within the field of synergetics especially. If we are able to discover spectra of evolutionary aims within complex systems, the role of humans and their responsibility in choosing the most favorable scenario of development will take on new levels of significance.

From the standpoint of synergetics, a change of emphasis in the approach to global problems is required: *we must abandon arm-twisting and power policy and instead search for ways of co-evolution to improve the complex social and geopolitical systems in the world*. The pursuit of policy by power methods is too dangerous in the modern, complex, non-linear world, where even random bugs in the ramified information and computer networks can cause a global catastrophe. The more complex a system is, the more functions it performs, and the more unstable it is. Therefore, efforts to better understand the heterogeneous structures situated on different levels of co-evolutionary development become a constructive alternative to today's policies based on force.

The world we live in is non-linear, open, and creative. Unexpected and often, charming novelties appear in it. In this non-linear world, the future is multiple and

17 Dennis Gábor: *Inventing the Future*, Gretna, LA: Pelican Books 1964, p. 161.

uncertain. You might call it a fuzzy future. The non-linear world frequently surprises us. In such a world, the probability of even the most improbable events coming to be actually increases. Our hope for a bright future depends on our deliberate choice of actions and how those actions conform to the inner trends of complex organizations, but also on our good luck that our chances of attaining the unattainable are growing.

Synergetics reveals the laws underlying these emergent phenomena. We suggest that synergetics can be used in futures studies as a non-traditional and productive methodological basis for explaining individual and social activity. The modern theory of complexity is an optimistic attempt to cope with non-linear situations and implement effective methods of managing complex systems in states of instability. This is the way of attaining a desirable and, at the same time, realizable future, a future in accordance with the properties of complex systems.