Introduction

Once More about Aspects, Directions, General Patterns and Principles of Evolutionary Development

Leonid E. Grinin and Andrey V. Korotayev

The present volume is the fourth issue of the Almanac series entitled 'Evolution'. Thus, one can maintain that our Almanac, which has actually turned into a Yearbook, has succeeded (see below).

The title of the present volume is 'From Big Bang to Nanorobots'. In this way we demonstrate that all phases of megaevolution and Big History are covered in the articles of the present Yearbook. Several articles also present forecasts about possible future developments.

The main objective of our Yearbook as well as of the previous issues (see Grinin, Korotayev, Carneiro, and Spier 2011a, Grinin, Korotayev, and Rodrigue 2011a, Grinin and Korotayev 2013a) is the creation of a unified interdisciplinary field of research in which scientists specializing in different disciplines could work within a framework of unified or similar paradigms, using common terminology and searching for common rules, tendencies and regularities. At the same time for the formation of such an integrated field one should use all available opportunities: theories, laws and methods. In the present volume, a number of such approaches including those which will be described below are used.

One of the most popular approaches in this respect is universal evolutionism which is the description of the major evolutionary trend (Big History, cosmic evolution); several articles on this topic were published in our previous issues (Grinin *et al.* 2011b; Grinin, Korotayev, and Rodrigue 2011b; Grinin and Korotayev 2013b[1]). This aspect has always been of special (and understandable) interest for those evolutionists who, following Herbert Spencer, aimed at defining evolution as a transition from the simple to the complex, from less developed to more developed, *etc.* (Spencer 1972 [1862]: 216, 71). At present Big History and the theory of megaevolution face very complicated issues whose solutions have not been found yet: Is this the direction of intergalactic or only planetary (local) character? Is this a development cycle consisting of de-

[1] See also, *e.g.*, Grinin *et al.* 2015; Rodrigue, Grinin, and Korotayev 2015a, 2015b.

stroying and creating cosmic civilizations? Does one need to use an anthropic principle to explain it?[2] Undoubtedly, one can observe this trend within the interval of megaevolution about which the contemporary science is able to propose some reasonable hypotheses.

But universal evolutionism naturally has its own limits and vulnerabilities.

First, the universal evolutionism examines only one evolutionary trend (which is in certain respect the major one); meanwhile, it is necessary to pay attention to other trends and aspects as well.[3] Let us note that the similarities between objects and processes of different nature can become evident (and are often found) within the secondary trends (*e.g.*, the similarity between social insects and the society).[4]

Second, the universal evolutionism is supported by a rather narrow theoretical base of the unity of the world. In addition to distinguishing the historical and genetic unity it is necessary to find an ontological base for the unity which would be based on common principles, laws, and rules showing the internal similarity of the existence and functioning of the matter at all phases of its development.

Third, it is necessary to examine the common features disregarding the differences in nature and complexity of the objects; thus, one can formulate certain (but rather general) principles of 'behaviour' of the objects belonging to different evolutionary levels.

Fourth, one can postulate the unity of evolution proceeding from the assumption about the general principles (which originated genetically or typologically) of the world structure. To find out the general elements of this structure, one should compare the evolutionary levels (fields) applying different criteria.[5]

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[2] The anthropic principle, which does not have the general formulation, reveals the presence of relationship between large-scale properties of the expanding Universe and the origin of life, reason, cosmic civilizations. Sometimes this principle is interpreted as the principle which explains 'extremely fine-tuned Universe' (see Davies 1993). Of course, in terms of the anthropic principle such important phenomena as the emergence of carbon and atoms of heavy elements, the formation of galaxies, planets, etc. are crucial for the Universe. With respect to inanimate nature, we can also use the notion of *preadaptation* (which means possessing the characteristics which appear to be decisive during the transition to a different environment, *e.g.*, from water to land) (about such preadaptations see Grinin 2014a, 2014b).

[3] As Eric Chaisson points, 'As such, it mainly concerns, in reverse order of appearance, changes that led to humankind, the Earth, the Sun, and the Milky Way Galaxy. Scant treatment is given, or need be given, to other galaxies, stars, or planets throughout the almost unimaginably vast Universe, for the goal of Big History is to place humanity itself into a larger cosmic perspective (Chaisson 2012: 38).

[4] In Fred Spier's article published in one of the previous issues of the Yearbook (see Spier 2011b: 32), special attention is paid to the idea that the transition to a new quality (new complexity, according to Spier) probably occurs on the outer edges of galaxies and other systems. And the article by Leonid Grinin, Andrey Korotayev, and Alexander Markov considers the rule of special conditions for the emergence of aromorphoses (which is in many respects applicable to the whole process of megaevolution) (Grinin, Korotayev, and Markov 2011).

[5] Alexander Krushanov writes, 'If by the present time within various scientific disciplines there has been already found a much greater (than it has been previously assumed) uniformity of objects

In the previous issues of our Yearbook we have tried to overcome the above mentioned restrictions. In particular, the unity of evolution on the theoretical and epistemological levels as well as the directions of the search for a general theoretical base for the evolutionary studies are analyzed in the Introduction to the first volume of the 'Evolution' Yearbook (Grinin, Korotayev, Carneiro, and Spier 2011b). The article by Grinin, Korotayev and Markov 'Biological and Social Phases of Big History: Similarities and Differences of Evolutionary Principles and Mechanisms' in the second volume of the Yearbook considers the general laws and rules for biological and social evolution (Grinin, Korotayev, and Markov 2011; Grinin, Markov, and Korotayev 2011). In the present volume, the article by Leonid Grinin 'Cosmic Evolution and Universal Evolutionary Principles' is devoted to the analysis of universal evolutionary principles which are revealed at different phases of Big History.

One can find many similarities between all types of macroevolution. However, unfortunately, there are few works on the opportunity to reveal them. In the present Introduction we will briefly consider a number of quite important similarities but unfortunately in a rather unsystematized manner as they are presented here only as an illustration of some important aspects which in our opinion clearly show the systemic-structural and evolutionary functional unity of the world starting from the microworld up to contemporary global humankind. In fact one can distinguish several similarities and group them into large blocks.

The capacity for development, self-preservation and self-organization. Evolution, that is the changes of objects, actually means the destruction of their stability and identification. From this point of view, at any stage and in any sphere of evolution the matter can be divided into two types: the first one is able to self-preservation and the second one is able to self-transformation (of course, these characteristics are present to a different degree). In other words, one can speak about evolving and non-evolving matter. There exist rather conservative elements even within human society and there still exist some societies which are not quite prone to changes, especially this phenomenon was strongly pronounced in the previous epochs. An average lifespan of a biological species is less than 10 million years. At the same time there are species which have endured for 200–300 million years, and the presumable age of blue-green algae is several billions years, that is they have not changed significantly since the Archean Eon. At any phase, the evolving matter makes up the minority (see Nazaretyan 2011); thus, the light (baryonic, stellar) matter according to some current views amounts for only 3–5 per cent. And such proportion is relevant even to the human society in which, according to some reports, the number of innovators is also 3–5 per cent. But at the same time, we suppose that just in the course of evolution of this comparatively small part of the matter the latter ac-

and processes which are related to different structural levels of the Universe, then who can at present categorically determine the limits of such uniformity?' (Krushanov 2007: 247).

quired the ability to self-organization. Many scientific disciplines, including Complexity Studies and Cybernetics, deal with the processes of self-organization of the matter. Self-organization is one of the most important and universal properties of the matter at any stage of evolution. One can say that the stronger the property of the matter to evolve, the stronger is its ability to self-organization and interaction with the environment. The issue of interaction with the environment, which is typical of evolution, can be illustrated by the problem of 'wastes' resulting from objects' functioning and of the best ways to get rid of the wastes. This is a cross-cutting evolutionary and more urgent problem of the present time. Fred Spier considers this aspect from a rather interesting point (Spier 2011b).

Let us note once again that the inability to evolve means the ability of the matter to self-preservation; thus, the dark matter (the composition of this matter is still unknown) has probably undergone no significant changes over the last 13–14 billion years after the Big Bang, and perhaps, it had existed before this event. Though the latest discoveries confirm the consistency of the dark matter and dark energy (cosmic vacuum), one can suppose that they are capable to transformations, but it takes much more time for the dark matter to transform than for the light matter. But some time ago the stars used to be considered unchangeable too.

The law of the age stages/phases of object's life. Oswald Spengler (1993) and Arnold Toynbee (1991) are known for their theories of civilization which stated that every civilization passes through certain stages of life (birth, youth, maturity, and decline) before the collapse. The similar idea was suggested more categorically by Lev Gumilev, who stated that the life period of any ethnic group from its birth till death lasts for 1500 years and during its life time an ethnos passes through the same stages (see Gumilev 1993). This idea still arouses discussions; but still the idea of certain phases of social organisms' life is rather reasonable. But while in social life a society can prolong its life and retrieve its dynamism at the expense of innovations and reformations, in the case of evolution we clearly observe that all material objects and systems have a certain lifespan and pass a certain phase. It is quite obvious among the biological organisms and even species. The stars also have certain life phases. After the phase of ordinary thermonuclear reactions, which is called the main sequence phase, is completed, a star transforms into a white dwarf (after passing the red giant stage) or (having a large mass) into a neutron star. One can find certain phases within the life span of many other objects as well.

The rule of 'block assemblage' in evolution. This rule was formulated by Grinin, Korotayev and Markov (see Grinin, Markov, and Korotayev 2009, 2011) for the analysis of the similarities between biological and social macroevolution.[6] However, it is quite relevant for the cosmic, chemical and geologi-

[6] For the analysis of some other similarities between biological and social evolution see also, *e.g.*, Grinin, Korotayev, and Markov 2011, 2013; Markov and Korotayev 2007a, 2007b, 2008; Markov, Anisimov, and Korotayev 2010; Korotayev and Markov 2014.

cal phases of evolution. The essence of this rule is that in the course of evolution there emerge some elementary and more complex units, systems and constructions which are used in different variations. The elementary particles are the units which form the atoms. With the emergence of atoms there also emerge the stellar systems, and in the stellar interior new types of atoms including heavy elements are formed from additional elementary particles. Due to the diversity of emerging atoms one can speak about a chemical evolution. Atoms are the universal units and components for the formation of various molecules and this marks the beginning of geological and then of a complex molecular organic evolution leading to life. The cell becomes an element for the formation of living organisms; there progressively emerge entire blocks of organs and systems which are surprisingly similar in different classes and even types of living organisms. One can recall genes and chromosomes as standard components and blocks of biological systems. One can insert a gene of a mouse into an elephant DNA, and the human gene – into the bacteria! Thus, there is a striking standardization of elements and 'components' at all evolutionary levels; and since entirely new objects within evolution are for 90–99 per cent created from the already existing components, the speed of evolution increases dramatically. Let us also add that in human society the borrowing occurs rather frequently: societies adopt (sometimes as complete wholes) religions, legal, political and technological systems. As a result we observe the phenomenon of globalization in the course of which the unification reaches an unprecedented level.

The unevenness and catastrophes (gradualism and catastrophism). Within evolution, periods of slow changes (accumulations), that is of an evolution in its narrow sense, are alternated by rapid metamorphoses and qualitative transformations (which sometimes look like revolutions) and periods of explosive growth are followed by catastrophes. In geology and paleontology there were hot debates between proponents of catastrophism (the school of the famous paleontologist George Cuvier) and adherents of gradual changes (*e.g.*, Charles Lyell) whose approach is known as 'gradualism'. The victory of the latter was a progress; however, later it became clear that it was very difficult to explain many things by slow and insignificant changes only. Thus, the evolutionary theory was enriched by the ideas of leaps, revolutions, and catastrophes enabling us to understand how and why the world kept changing. It is important to note that catastrophism is an essential part of evolution at all its stages. The idea of 'Big Bang', the biggest 'catastrophe' in the history of the Universe, underlies its origin. Thus, catastrophes appear to inevitably accompany the development and evolution, to be a kind of compensation for the development and rapid growth (and at certain evolutionary stages – a compensation for progress). In cosmic life, catastrophes are an inevitable result of long life of stars which, after having depleted their energy reserves, turn into the white dwarfs or red giants and sometimes they produce extremely bright outbursts of light – the outbursts of supernova. In the field of biology, the catastrophes are the great extinctions which enabled new progressive species to appear. It should be noted that the catastrophes provide an abundant data for the scientific reconstruction of the past events. Thus, as a result of the study of supernova's outbursts, the spectrum shift analysis served a firm foundation for the discovery (one of the most important in astrophysics and the most important for the last 15 years) of antigravitation of cosmic vacuum (the so-called dark energy) which constitutes the vast majority of the total mass of the Universe.

The typical and the unique objects. On the one hand, one cannot help wondering at the Nature's 'production-line' ability to create millions and billions of exceptionally similar copies of the same objects. The issue of ideal eternal essences and real copies-existences of things has been the philosophers' main concern since ancient times. But, on the other hand, the variability of objects which are similar in type is undoubted. In fact, every star is very different from another even if it belongs to a narrow classification group (and there are a lot of such groups). And even if the stars are formed (like enzygotic twins) from one gas-dust cluster (as a result of a single outburst of supernova, *etc.*), still they differ in mass, chemical composition, the presence or absence of planetary system (and in the planetary system types), brightness, characteristics of reactions, and position. None of the biological species is identical with another. The same refers to human beings (various papillary patterns on the fingers, unique genetic code, *etc.*). Not so long ago we believed that animals act like mechanisms according only to their genetically determined instincts. But at present, ethology identified a large range of individuality among animals as well as among insects (see, *e.g.*, Reznikova and Panteleyeva 2012). Thus, *typical and unique (individual) characteristics* are peculiar to all macroobjects in nature. At the same time individuality increases as the evolution develops. Probably, the number of variability attributes increases along with the complication of systems (*e.g.*, in human society, language, social position, nationality, *etc.* are added). Such analysis allows identifying the roots of the features which seem typical of humans only, as though they were inherent to Nature's grand scheme.

The variability of typical objects (belonging to one class, species, group, *etc.*) is the most valuable tool of evolution which allows selecting variations of attributes (as well as their concentration, *etc.*) which are the most appropriate for a variety of tasks. A qualitative breakthrough can occur only as a result of the emergence of unique circumstances (whose possible occurrence is significantly increased through variability). Finally, only the endless variety of stars, planetary systems, planets and preceding events could be a trigger of emergence of life on planets of the Earth type. But it is quite likely that, in the field of microworld, elementary particles, atoms and molecules might also have some individual features which may be found out to affect (through certain mechanisms) some properties. It is impossible to identify the differences between the grains of sand with the naked eye, but it is easy to do it under the microscope.

Recombination, or the circulation of matter of similar class in nature. The Nature's workshop is based not only on the selection from the diversity but also on a constant remaking of objects. Every object has its own lifespan, therefore its decaying substance is involved into the circulation and new objects are formed from it. New stars are formed from exploded stars but they differ from their predecessors and this brings about an increasing diversity and enhances chances of the emergence of something brand new. Decayed biomass is a source of nutrients to support the reproduction and life of other living creatures. On debris of a destroyed empire a new one appears. On the one hand, in inanimate nature we observe a strong ability to direct and reverse transitions (contraction and expansion of the matter), transformation of energy into matter and vice versa; thus, the rebirth of a star from a gas-dust cloud is possible (*but it is impossible to make an exact reproduction of a unique object as it is the general characteristic of nature*). The irreversible character of processes is much more evident in animate nature. But in human society we observe an increasing irreversibility of typical processes at a certain level (not in the sense of revival of people but of the revival of social organisms which are very different from the animated organisms in a number of parameters). Thus, the *decay and revival (in different ways) of objects (organisms) is a general law of evolution/the Universe.* We say 'of the Universe' because these processes are ensured by the laws of perdurability of matter and energy. We say 'of Evolution' because these processes allow some constant testing of new variants (in biology they also include mutations and in human society – deliberate changes which accelerate the given process, but its general basis consists in individualization of objects and recombination of the matter/energy). On the other hand, as the evolution becomes more complicated, the effect of mutual influence emerges resulting from the recombination of matter. Thus, the living matter produces a huge impact both on geological changes (organic raw materials – coal, oil[7], soils, *etc.*, not to mention the oxygen which appeared in the atmosphere as a result of the greatest aromorphosis in animate nature – of the transition from anaerobic to aerobic dissimilation) and on the geographic ones (the emergence of islands, *etc.*) while the anthropic matter influences both animate and inanimate nature (channels, ploughing up, *etc.*).

Here we complete our survey of the universal similarities and patterns (note that there are also some interesting examples and conclusions in Leonid Grinin's article in the present Yearbook).

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The present Yearbook consists of four main sections.

Section I. Universal Evolutionary Principles comprises four articles.

Leonid E. Grinin. 'Cosmic Evolution and Universal Evolutionary Principles'.

The given article attempts at combining Big History potential with the potential of Evolutionary Studies in order to achieve the following goals: 1) to apply the historical narrative principle to the description of the star-galaxy era

[7] However, there are some theories about their inorganic origin.

of the cosmic phase of Big History; 2) to analyze both the cosmic history and similarities and differences between evolutionary laws, principles, and mechanisms at various levels and phases of Big History. We think that nobody has approached this task in a systemic way yet. It appears especially important to demonstrate that many evolutionary principles, patterns, regularities, and rules, which we tend to find relevant only for higher levels and main lines of evolution, can be also applied to cosmic evolution. Moreover, almost everything that we know about evolution may be detected in the cosmic history, whereas many of the evolutionary characteristics are already manifested here in a rather clear and salient way. Of course, many of the characteristics are manifested in initial or nonsystematic forms but some features, on the contrary, appear to be more distinct just in the cosmic phase. And at the same time when many characteristics and features which are typical of biological and social evolution unexpectedly reveal their roots or protoforms at earlier phases, one becomes aware that the universal character of evolution is real and it can be detected in a number of manifestations. One should also bear in mind that the origin of galaxies, stars, and other celestial objects is the lengthiest evolutionary process among all evolutionary processes in the Universe. Such an approach opens new perspectives for our understanding of evolution and Big History, of their driving forces, vectors, and trends, it also creates a consolidated field for the multidisciplinary research.

David LePoire. 'Potential Nested Accelerating Returns Logistic Growth in Big History'.

The discussions about the trends in rates of change, especially in technology, have led to a range of interpretations including accelerating rates of change and logistic progress. These models are reviewed and a new model is constructed that can be used to interpret Big History. This interpretation includes the increasing rates of the evolutionary events and phases of life, humans, and civilization. These three phases, previously identified by others, have different information processing mechanisms (genes, brains, and writing). The accelerating returns aspect of the new model replicates the exponential part of the progress as the transitions in these three phases started roughly 5 billion, 5 million, and 5,000 years ago. Each of these three phases might be composed of a further level of about six nested transitions with each transition proceeding faster by a factor of about three with corresponding changes in free energy flow and organization to handle the increased generation rate of entropy from the system. Nested logistic transitions have been observed before, for example in the ongoing exploration of fundamental physics, where the progress so far suggests the complete transition will include about 7 nested transitions (sets of subfields). The reason for this number of nested transitions within a larger transition is not known, although it may be related to the initial step of understanding a fraction of the full problem. Too small of an initial fraction would lead to incomplete problem scope and definition. Too large of an initial step would lead to complications between the development of basic understanding and higher level derivations. An original step of one-seventh of the problem ends up within one standard deviation from the inflection point (mid-way through the transition).

David Christian. 'Universal Darwinism and Human History'.

This essay discusses Universal Darwinism: the idea that Darwinian mechanisms can explain interesting evolutionary change in many different domains, in both the Humanities and the Natural Sciences. The idea should appeal to Big Historians because it links research into evolutionary change at many different scales. But the detailed workings of Universal Darwinism vary as it drives different vehicles, just as internal combustion engines differ in chain-saws, motor cycles and airplane engines. To extend Darwin's ideas beyond the biological realm, we must disentangle the biological version of the Darwinian mechanism from several other forms. The paper focuses particularly on Universal Darwinism as a form of learning, a way of accumulating information. This will make it easier to make the adjustments needed to explore Darwinian mechanisms in human history.

David Baker. 'Collective Learning as a Key Concept in Big History'.

One of the key concepts for the human part of the grand narrative is known as 'collective learning'. It is a very prominent broad trend that sweeps across all human history. Collective learning to a certain degree distinguishes us as a species; it got us out of Africa and the foraging lifestyle of the Palaeolithic, and underpinned demographic cycles and human progress for over 250,000 years. The present article considers at collective learning as a concept, its evolution within hominine species, as well as its role in human demography and the two great revolutions in human history: agriculture and industry. The paper then goes on to explain the connection of collective learning to Jared Diamond's 'Tasmanian Effect'. Collective learning also played a key role in the two 'Great Divergences' of the past two thousand years. One is industry and the rise of the West, described to great effect by Kenneth Pommeranz, the other is the less well known: the burst of demography and innovation in Song China at the turn of the second millennium AD. Finally, the paper concludes with insights into how collective learning forges a strong connection between human history and cosmology, geology, and biology, through what is widely recognized as one of the 'unifying themes' of Big History – the rise of complexity in the Universe.

Craig Benjamin. 'Collective Learning and the Silk Roads'.

The Silk Roads are the quintessential example of the interconnectedness of civilizations during the Era of Agrarian Civilizations, and the exchanges that occurred along them resulted in the most significant collective learning so far experienced by the human species. The primary function of the Silk Roads was to facilitate trade, but the intellectual, social, and artistic exchanges that resulted had an even greater impact on collective learning. The Silk Roads also illustrate another key theme in Big History – evolving complexity at all scales. Just as the early universe was simple until contingent circumstances made it possible for more complex entities to appear, and that the relatively simple single-cell organisms of early life on the planet were able to evolve into an extraordinary, complex biodiversity, so human communities and the connections between them followed similar trajectories. The comingling of so many goods, ideas, and diseases around a geographical hub located deep in central Eurasia was the catalyst for an extraordinary increase in the complexity of human relationships and collective learning, a complexity that helped drive our species inexorably along a path towards the modern revolution.

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Section II. Biosocial Evolution, Ecological Aspects, and Consciousness consists of five contributions.

Andrey V. Korotayev, Alexander V. Markov, and Leonid E. Grinin. 'Modeling of Biological and Social Phases of Big History'.

In the first part of this article we survey general similarities and differences between biological and social macroevolution. In the second (and main) part, we consider a concrete mathematical model capable of describing important features of both biological and social macroevolution. In mathematical models of historical macrodynamics, a hyperbolic pattern of world population growth arises from non-linear, second-order positive feedback between demographic growth and technological development. Based on diverse paleontological data and an analogy with macrosociological models, the authors suggest that the hyperbolic character of biodiversity growth can be similarly accounted for by non-linear, second-order positive feedback between diversity growth and the complexity of community structure. They discuss how such positive feedback mechanisms can be modelled mathematically.

Alexander D. Panov. 'Prebiological Panspermia and the Hypothesis of the Self-Consistent Galaxy Origin of Life'.

The author argues that the panspermia can mean not only the other place of the origin of life but also another mechanism of the origin of life that increases the probability of the origin of life to many orders compared to a single-planet prebiological evolution. The prebiological evolution can be an all-Galaxy coherent process due to the fact that prebiological panspermia and the origin of life are similar to Galaxy-scale second-order phase transition. This mechanism predicts life to have the same chemical base and the same chirality everywhere in the Galaxy.

Olga A. Sorokina and Rendt Gorter. 'Social Evolution of Humankind as an Integral Part of the Evolution of the Biosphere'.

A theoretical reconceptualization of social evolution is proposed in order to construct the principles for socio-economic governance that can expand the resilience of global systems that in turn determine the world's carrying capacity for the human population. Big History approach shows how world societies are in a transition phase that can be explained using evolutionary laws with the understanding that the development of human civilization is considered as an integral part of the evolution of the Earth's biosphere.

Michael Charles Tobias and Jane Gray Morrison. 'The "Ahimsa Factor": Ecological Non-Violence Process Analysis in China and its Implications for Global Paradigmatic Shifts'.

The world is witnessing the sixth extinction spasm in the annals of 4.2 billion years of life on Earth. We lose some 40,000 discrete populations of organisms every day. Species and habitat loss exceeds anything comparable during the last 65 million years. The human population is poised to hit between 9.5 billion and – in the absolute worst case scenario, 15 billion – with all of its accompanying consumption. A new global paradigm that can set the gold standard for ecologically-humble human behavior is urgently required and the nation of China – the largest country in human history, by far – has the potential to set in motion the global processes that are a prerequisite to a new gold standard for rectification of ecological violence. This will be no easy challenge, to be sure. In this essay the authors examine some of the comprehensive biodiversity, global trade, ecological degradation, demographic and animal rights challenges facing the China of 2013 and suggest some solutions.

Ilya V. Ponomariov. 'Situational Binding and Inner Speech: Cross-Sectional Evidences'.

Different evidences of inner speech development are gathered and discussed from the perspective of situational binding – a conception developed within the framework of cultural-historical tradition of L. S. Vygotsky. This conception explains and systematizes many facts which have otherwise caused much perplexity to scientific knowledge. It predicts that the future neurobiological research of inner speech in non-school societies should discover that it has fragmentary and sympractical character.

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Section III. Projects for the Future contains three articles.

Valentina M. Bondarenko. 'Governing the Time will Govern Development – or, "Territory of Faster Development: Everything for People" Megaproject Realization Proposals'.

The author substantiates the thesis that the contemporary scientific knowledge has exhausted its explanatory potentials and does not contribute to definition of the objective causes of the emerging systemic crisis in Russia and in the world. Hence, such knowledge does not help to conduct the search and to substantiate transition to the new economic growth model, although Russia in its current condition is doomed to stagnation, further slow-down of growth rates, increase in unemployment and poverty. As argued further on in the article, only by reaching the visionary level of understanding the roots of the emerging systemic crisis and all other problems it has become possible to form the methodology for cognition of regularities in the human system development, and then, basing on the given methodology, to substantiate the need and possibility to realize the megaproject of 'Territory of Faster Development: Everything for People'.

Vasily N. Vasilenko. 'The Noospheric Concept of Evolution, Globalization and Big History'.

The followers of Vladimir I. Vernadsky's ideas claim that the relevance of the biospheric concept is increasing, as well as the biosphere-noosphere transition, thereby providing public safety and reaching sustainable development. Philosophical, ontological and futurological nationwide recognition of Vernadsky's legacy is proved by including the 150th anniversary of Vladimir Vernadsky in the UNESCO calendar of anniversaries under the title 'Noospheric Thinking – the 21st Century Thinking'. The author considers the issues of Evolution, globalization and Big History from the perspective of noospheric paradigm. The issues deal with the future development of the civilization within the Earth's biosphere. In order to take into account ecological threats for citizens in different regions of the planet, the criterion of noospheric approach to globalization challenges was chosen.

Anton L. Grinin and Leonid E. Grinin. 'Cybernetic Revolution and Forthcoming Technological Transformations (the Development of the Leading Technologies in the Light of the Theory of Production Revolutions)'.

The article analyzes the technological shifts which took place in the second half of the 20th and early 21st centuries and forecasts the main shifts in the next half a century. On the basis of the analysis of the latest achievements in innovative technological directions and also on the basis of the opportunities provided by the theory of production revolutions the authors present a detailed analysis of the latest production revolution which is denoted as 'Cybernetic'. They offer some forecasts about its development in the nearest five decades and up to the end of the 21st century. It is shown that the development of various self-regulating systems will be the main trend of this revolution. The authors argue that at first the transition to the beginning of the final phase of the Cybernetic Revolution will start in the field of medicine (in its some innovative directions). In future we will deal with the start of convergence of innovative technologies which will form the system of MBNRIC-technologies (*i.e.* the technological paradigm based on medicine, bio- and nanotechnologies, robotics, IT and cognitive technologies). The article gives a detailed analysis of the future breakthroughs in medicine, and also in bio- and nanotechnologies in terms of the development of self-regulating systems with their growing ability to select optimum modes of functioning as well as of other characteristics of the Cybernetic Revolution (resources and energy saving, miniaturization, and individualization).

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Section IV. In Memoriam is devoted to George Modelski.

George Modelski was an outstanding American social scientist and world historian. He contributed to an impressive number of different research questions. Throughout a long and distinguished career, George Modelski emphasized the need to bring together theory, evidence, and history in the unraveling of the World System evolution. Although never widely cited or known in wide circles of social scientists, his contributions were always distinctively different and original.

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