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Mega-Evolution and Big History

Akop P. Nazaretyan

Abstract

Big History – an integral conception of the past, from the Big Bang until today – is a relatively new and unique subject of cross-disciplinary interest. The concept was construed in the 1980–90s simultaneously in different countries, after certain basic concepts had matured in the Sciences and the Humanities. Various versions and traditions of Big History are considered in this article. In general, most Western authors emphasize the idea of equilibrium, and thus reduce cosmic, biological and social evolution to mass-energy processes. Furthermore, they view the information parameter, involving mental and spiritual aspects, as mere epiphenomena of increasing complexity – only adjunct to material structures, ones that do not play their own role in evolution. In the Russian tradition of Big History, however, sustainable non-equilibrium patterns are used. This implies attention be paid to pan-material sources and evolution of mental capacities and spiritual culture (as basic anti-entropy instruments) and humans' growing intervention in the material processes on Earth and off of it. The non-equilibrium approach, in the context of modern control and self-organization theories, alters the portrayal of the past, and even more dramatically, the estimation of civilization's potential.

Mega-evolution is the chain of transformations that have taken place in the Universe over a period of 13.7 billion years. As we study this subject, we can find how more and more complex forms of organization, mechanisms of activity, and systems of reflection have been arising, and perhaps will continue to rise. This highly intricate subject requires new interdisciplinary paradigms and methodologies for us to integrate all the data about the physical Universe, the Earth, the biosphere, society, culture and mind into a single model.

From the 1970s into the 1990s, an assemblage of such holistic knowledge was developed by scholars from various academic backgrounds in North and South America, Australia, Western Europe and Russia. Initially, these scholars worked independently and without much contact, but new networks developed by the end of the 20th century, as work on mega-evolution gained acceptance in the world's academic community. Indeed, in November 2005, an international conference in Dubna (Russia) paraphrased the slogan

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from the Communist Manifesto: 'The Specter of Big History is Roaming the Earth'.[1]

Big History is one of the names for the study of mega-evolution. It is a research program aimed at the synthesis of Natural Sciences, Social Sciences, and the Humanities. Through Big History, we try to identify megatrends, mechanisms and regularities in evolution, the specific character of processes at each stage of development, and the peculiarities in phase transitions. It is worth mentioning that the interest of professional historians in this interdisciplinary field has lately been increasing.

As recently as the 1980s, most historians in the West (unlike their Russian colleagues) disdainfully treated research exceeding three generations as 'sociology', while 'middle level conceptions' in sociology were referred to as 'philosophy'. Since 2000, however, researchers have been paying attention to the growing interest in historical generalization (McNeill and McNeill 2003) and relate it to efforts at global modeling of social trends. Big History's retrospective outlook also has been provoking interest from social historians.

This acceptance of the study of mega-evolution has been in reaction to the inertia of mono-disciplinary thinking, on the one hand, and insufficient methodology for integration of heterogeneous studies, on the other. Therefore, it is symptomatic that a growing number of historians are recognizing the value of using the telescope and the microscope as instruments for assessing the past. And, since 2005, the World History Association has increasingly included Big History panels at its conferences.

The Constructs of World, Global and Big History

The medieval historians were, in J. Le Goff's (1977) expression: 'great provincials'. Each described the events they observed as the center of human history and had no reason to reflect on the differences between separate civilizations' stories. Geographic discoveries, colonial conquests, geologists' and archeologists' findings, and especially a new mentality broadened the Europeans' space and time horizons.

Formation of nations, nation states, and national ideologies resulted in discrimination and conceptual confrontation between local histories. In the 18th

[1] The projects and courses known as Big History in English have different names in other national traditions: *Universalnaya Istoria* in Russia, *Weltallgeschichte* in Germany and *mega-historia* in Latin America (Christian 1991, 2004; Spier 1996, 2010; Chaisson 2001, 2005, 2006; Hughes-Warrington 2002; Brown 2007; Velez 1998; Moiseev 1991; Nazaretyan 1991, 2004, 2008, 2010a, 2010b; Neprimerov 1992; Fedorovich 2001; Panov 2005, 2007). They had also particular denominations from the 1970s to the 1990s, like *Cosmic Evolution* (E. Chaisson in the USA, see in this issue) or *The Universe* (N. Neprimerov in Russia). In Russian universities, inter-faculty Big History courses are sometimes taught under the heading of 'The Conceptions in Modern Science', which fits under the standards of the Ministry of Education. Recent formats in Big History can be seen in Rodrigue and Stasko 2010 and at http://usm.maine.edu/lac/global/bighistory/.

and 19th centuries, a conception of *world history* appeared with national histories and was based on the idea of pan-human progressive development. Current versions of it have divisions into periods, ascending from prehistory to modern times.

Originally, world history was Eurocentric, which was strongly criticized by adherents of the 'civilization approach' in the 19th and 20th centuries, such as Nikolay Danilevsky, Oswald Spengler, the early Arnold Toynbee and others. Later, historical particularists, post-modernists, and religious and national fundamentalists joined the debate. Together with Eurocentric ideology, the idea of pan-human history was denied. Spengler (1980) even proposed to consider *humankind* as merely a zoological concept.

In the 21st century, the world-history concept is still not yet shared by all historians or sociologists. Nonetheless, archeological, anthropological and historiographical discoveries disavowed two key arguments by Danilevsky and Spengler: 1) There had been no continuity between the developments of regional civilizations; and 2) There had been no meaningful events for all of humankind. Since we now have abundant evidence for the mainstream of human history and prehistory in a scientific (as opposed to ideological) discussion, one may question certain interpretations, but not world history as a subject matter.[2]

Moreover, in the first half of the 20th century, the profound mutual influence of geological, biological and social processes was revealed. As a result, a novel cross-disciplinary field took shape – *global history:* The planetary story seen as the successive formation, evolution and interaction of the structures in which first biota and then society turned out to be the leading agents.

Russian biochemist Vladimir Vernadsky, French anthropologist Pierre Teilhard de Chardin, and philosopher Édouard Le Roy were among the discoverers of global history. They showed that human history was a phase in the evolution of the Earth, which they predicted would culminate in a 'Noosphere' – the sphere of maximum intellectual control over planetary processes. Among those who contributed to the global history approach were (Golubev 1992; Snooks 1996, 2002, 2005; Iordansky 2009; Grinin, Markov, and Korotayev 2011; Lekiavičius 2011). Particularly, the Australian global scientist Graeme Snooks has developed and applied a general dynamic theory of life and human society.

It is curious that when Vernadsky (1978) wrote in the 1930s, although he did not pass over the question of evolutionary standpoint existing beyond Earth and the Solar System, his answer was in the negative. Not being a specialist in theoretical physics, he ignored relativist cosmological models, and – like most

[2] We have singled out five mainstreams of consecutive global transformations for millennia: *increases of world population, of technological power, of organizational complexity, of mental information capacity*, and *perfection of cultural regulation mechanisms*. The first three vectors are inferred as 'empirical generalizations' that can be easily illustrated by figures. The fourth and the fifth ones require particular arguments (Nazaretyan 2004).

of his contemporaries – shared the idea of a stationary, isotropic and infinite universe. That idea, which descended from Giordano Bruno, obviously contrasted with universal evolution: Eternity cannot have a history! Since the Russian scientist did not see an alternative to a Brunian view of the Cosmos, he had to recognize that the evolutionary processes on Earth were nothing but an ordinary local fluctuation, which was doomed to dissolve with time in the infinite universe, like an ocean wave. As to the universe as a whole, he argued, it had always remained and would always remain exactly as we find it.

Before Vernadsky, many outstanding thinkers (Francis Bacon, Nicolas de Condorcet, Charles Fourier, Friedrich Engels and others) had been racking their brains over the problem of concordance between a philosophy of progress and a naturalist vision of reality. All of them, more or less explicitly, came to the same discouraging conclusion: No infinite perspective for life and spirit is thinkable, if the destinies of the Earth and Sun are limited. At best, it was assumed that eternal matter was regularly producing splashes, like evolution on Earth, in various points of cosmic space; any continuation or progression between those local stories were external to the discussion.

Only the most reckless of the German and Russian 'Cosmists' dared to argue that human intelligence would lead its bearers from their cradle planet far into cosmic space, guaranteeing infinite progress to Earth's civilizations. The first proponents of these Cosmist views were Johann Gottlieb Fichte, Nikolay Fedorov and Konstantin Tsiolkovsky. These visionaries were considered a laughingstock by many of their contemporaries. Yet, even the Cosmists had a limited vision – they extended their evolutionary outlook into the future but not backwards on the past: The pre-human Cosmos remained outside their view of history.

As to 'respectable' science, the only reason it could be assumed to have adopted a universal mega-trend up to the 20th century is through the second law of thermodynamics. Its rational corollary stated that, if the world was a single whole, it would continually degrade from maximum organization to absolute entropy. The heat-death theory of physics harmonized with the biological theory of catastrophes that was argued by the father of Paleontology, Georges Cuvier: New living forms cannot spontaneously emerge and their original diversity has successively decreased because of geological and cosmic cataclysms. The concept of social and spiritual decay constituted the roof over this theoretical building, which had been raised well before the building's walls and groundwork appeared!

While the idea of a descending trend had powerful alternatives in 19th century sociology and biology (Auguste Comte, Herbert Spencer, Charles Darwin, Karl Marx), Physics could set off against the heat-death theory only a thesis that the infinite universe was an open system and therefore free from thermodynamic laws, *ergo*, from history. However, empirical data testified to the consecutive evolution of life and society, while relevant conceptual conclusions

strongly contrasted with thermodynamic generalizations. In philosopher Roger Caillois' (1976) words: 'Clausius and Darwin cannot both be right'.

Big or Universal History is a concept that considers evolution from the Big Bang to modern society. It took shape from about 1980 into the 1990s. At least, two crucial achievements in the 20th century science influenced this trend.

First: Relativist evolutionary cosmology models had been mathematically deduced and then received indirect empirical support from discoveries, such as the red-shift effect, cosmic background radiation and others. Historical methods deeply penetrated into Physics and Chemistry: All material objects, from nucleons to galaxies, proved to be temporal products of a certain evolutionary stage, which had their histories, pre-histories and naturally restrained futures.

Second: A set of natural mechanisms were discovered by which open material systems could spontaneously move away from equilibrium within their habitats and – using the environment's sources for anti-entropy work – sustain their non-equilibrium conditions. Self-organization patterns became a subject of interest in the Sciences and the Humanities.

All the above-mentioned factors reveal that we can distinctly trace progressive vectors or mega-trends, which enter into social, biological, geological and cosmo-physical histories as a single and continual process. Moreover, although no direct contradictions with the laws of physical irreversibility have been found, the mega-trends' orientation conflicts with the classical natural science paradigm. Some astrophysicists (Chaisson 2001) describe this as the disparity between two 'arrows of time' – the thermodynamic and the cosmological ones.

Indeed, available data allows us to observe evolution from the quark-gluon plasma up to star clusters and organic molecules, from the Proterozoic cyanobacteria up to the higher vertebrates and most complicated ecosystems of the Pleistocene, and from *Homo habilis* with pebble chips up to post-industrial civilization. Thus, as far back as our view reaches, the Universe has been evolving from the more probable or 'natural' states, from an entropy point of view, to the less probable (or 'unnatural') ones.

True, the cone of evolution has been tapering. Most matter of the Universe (the so-called *dark matter*) has avoided evolutionary transformations and remained apart from atomic structures. A tiny portion of atomic structures has formed organic molecules. Living matter has apparently emerged in extremely rare and limited parts of cosmic space, and only one of hundreds of thousands of biologic genes on Earth has reached the social stage. Thus, we may agree with Eric Chaisson (2001) and David Christian (2004) that complexity and rarity go together. Still, the appearance of a qualitatively higher structure imparts a novel attribute of the Universe as a single whole. As Albert Einstein once noted, the state of the Universe is probably altered by a mouse just looking at it.

These new qualities are fraught with further development. Hence, an opposite trend to the cone of evolution is traced after a certain stage: The field of the mind's

influence has been growing as human activity has manifested a more profound physical effect. These effects are now spreading beyond the Earth, and there is no reason to see limits to this expansion (see below).

The Russian physicist Alexander Panov (2005) added a new trait to this model when he confronted the time intervals between the qualitative leaps in the evolution of Earth, nature and society. By using geo-chronological tables and human-induced global crises since the Lower Paleolithic, he found that the time spans decreased over the course of 4.5 billion years in conformity with a simple logarithmic formula.[3] This result, reported to the State Astronomic Institute (November 2003), was recognized as a scientific discovery by the participants. Panov's equation was conceptually pre-empted by Graeme Snooks (1996), who had formulated the 'law of cumulative genetic change': each great transformation of life was one-third the duration of its predecessor. This independent discovery offers complementary evidence for the unity of the Universal History, and a new context for global forecasts.

In order to give it a sharper graphic form, the pivotal evolutionary mega-trend may be drawn as a consecutive distancing, or 'digression from the natural (the most probable) condition'. On our whole retrospective view (about 13.7 billion years), our world has been getting 'stranger and stranger'. In fact, this conclusion is nothing but an empirical generalization deduced by simply comparing evidence from different disciplines. In spite of human-free choice, wrong actions, countless social fractures and 'civilization cycles', a bird's eye view of world history reveals its progressive ascent, which is a continuation of the mega-trends.

An obvious (or seeming) contrast between the two 'arrows of time' looks like *the pivotal paradox in the current scientific worldview*, which leaves open a wide range of conceptual interpretations. A question at the heart of the matter is why evolution has gone in such an odd direction.

The Versions of Big History

There is a temptation to explain universal evolution's paradoxical 'digression from the natural condition' by adopting an *a priori*, theoretical view focused on a final state. As soon as we do this, the most acute questions (beginning with 'why?') disappear and are replaced by relatively elementary ones (like 'for what?' and 'how?').

A vivid example of such a teleological argument in modern Cosmology can be seen in the 'strong anthropic principle'. This view implies that a very precise balance of physical conditions in the Universe made the emergence of living cells possible. In other words, humans are an artificial composition derived from the initial parameters in the giant laboratory of our Metagalaxy. Indeed,

[3] Panov used the first edition (2001) of the book (Nazaretyan 2004); see also (Nazaretyan 2010a, 2010b).

English astrophysicist Fred Hoyle said that interpretation of the facts from Physics, as in Chemistry and Biology, leads us to presume that they have been the result of a Super-Intellect's experimentation (Hoyle in P. Davies 1982).

In Biology, we find a similar argument represented by theories of nomogenesis and ortogenesis. To emphasize their essential idea, the outstanding Russian biologist Lev Berg (1977: 69–70) quoted from his predecessor, another enthusiast of nomogenesis Karl Bar: 'The final goal of the whole animal world is the human species'.

A similar teleological idea is metaphorically expressed in Karl Marx's famous words that 'the anatomy of humans is the key to the anatomy of monkeys'. Such a view still has deep roots in Sociology. Almost all progressionist theories in the 18th to the 20th centuries held to the belief that historical process consisted of ascent toward an ideal model. This argument generated severe criticism from its opponents. In the early 20th century, for example, Russian philosopher Nikolai Berdyaev advanced a strong anti-progressionist argument: The idea is immoral, he wrote, for it represents all previous generations as nothing but foot-steps on the way to the final aim (and thus deprives them of self-value) and the future generation of 'lucky-guys' as vampires reveling on the graves of their ancestors (Berdyaev 1990).

Classical and modern Philosophy includes more teleological doctrines than other disciplines. However, they all are exotic topics in Big History courses at the university level, and as far as I know, are hardly even mentioned. What prevails are *a posteriori* interpretations. This means that most scholars deduce evolutionary effects as consequences of actual interactions, so that a sequence within a certain mega-trend is seen as a *problem*, which needs a scientific solution.

For their part, though, *a posteriori* versions of evolution are not homogeneous either. In order to see the difference, we need to consider the recent history of the question. If we exclude myths and legends, as well as classical religious and philosophical doctrines concerning the beginning and the end of the world, then Erich Jantsch's paper, *The Self-Organizing Universe* (1980), seems to be the first that could be unconditionally referred to as Big History.[4]

Jantsch had emigrated from Austria to the United States, so his brilliant book was published in German and English, but it drew little interest from Western European or American scholars. Soon afterwards, he committed suicide (people living a hard life often write optimistic texts, and *vice versa:* Psychologists call it *compensation*). In my contact with Western colleagues in the 1990s, I was surprised to discover that none of them had even heard of Jantsch. *The Self-*

[4] Alexander von Humboldt, Herbert Spencer, Karl Marx, Friedrich Engels and other great European 19th century philosophers who tried to integrate the history of humans and the history of nature could not see the Universe as it is viewed after Albert Einstein and Alexander Friedman. Like Vernadsky, they had to limit their portrayal of evolving nature (or Cosmos) to the Earth and Solar System. Therefore, those books were not properly 'Big History' as we use the term.

Organizing Universe might have sunk into oblivion if it were not for a series of accidental circumstances.

Ironically, although Jantsch's book was never published in Russian, it had a stronger impact on Soviet readers than in Europe or America. In order to trace the reasons for this, we need to remember that the Russian physician and philosopher, and one of system theory's founders, Alexander Bogdanov, had focused on the study of *non-equilibrium systems* in the 1910s (Bogdanov 1996). In the 1930s, Soviet biophysicist Ervin Bauer first used the concept of *sustainable non-equilibrium*, which was further developed by the Russo-Belgian chemist, Ilya Prigogine. This concept was then philosophically adopted by Jantsch, who dedicated his book to Prigogine. As a result, the concept of non-equilibrium systems was more familiar to Russian scholars than their Western colleagues. In contrast, systems-thinking in Western Europe had almost exclusively focused on the idea of equilibrium (Ludwig von Bertalanffy, W. Ross Ashby and others), so Western scholars still used equilibrium patterns when they developed their forms of Big History in the 1990s.

This explains why Big History in Western universities has mostly ignored psychological considerations. In Prigogine's words, 'equilibrium is blind' and non-equilibrium gives a system sight (Prigogine 1981). In order to sustain a far-from-equilibrium condition, an organism must work in opposition to the environment's pressure. This work requires free energy to be extracted from other systems. So, in order to continually tap energy from outside and escape from itself becoming a source of energy for its enemies, an organism needs *information:* It has to orientate itself in the habitat, forecast events and organize its activity in conformity with a dynamic situation. In other words, it must construct anticipative world models.

Without this purposeful and highly sensitive anti-entropy activity, neither long-term, far-from-equilibrium conditions, nor the progressive building up of stages in living matter's non-equilibrium would be possible. For its own part, competition for matter and energy resources has served as an immutable motive for the perfection of modeling procedures, so that the specific weight of information *versus* matter/energy has been increasing with time. It is on the social stage that the mind became more and more the determinant cause of material evolution.

So, as we like to get rid of teleology, or the 'drive to evolution' assumption, we still have to assume living matter's drive to sustain highly improbable, far-from-equilibrium conditions. This occurs in a manner similar to Henri Bergson's *élan vital*, but, in order to avoid the French philosopher's dualism, we must seek the evolutionary premises of living organisms' immanent attribute.

As far as Big Historians in the West have used equilibrium patterns, they have tended to confine themselves to discussions of matter/energy interactions and underestimated the information processes. As a result, the history and pre-

history of subjectivity, as well as mental and spiritual reality, are viewed as epiphenomena (side effects) of material structures that do not play a role in evolution. In this way, the psycho-physical problem raised by René Descartes was simply removed.

This problem has moved from the 'philosophical' to the 'scientific' realm, as mathematical theories of communication and control have been developed. This move was highlighted when mathematician Norbert Weiner (1950) indicated that information was neither matter nor energy. Accordingly, after the basic question of Big History's methodology (teleological *versus* causal approach) is solved in favor of *a posteriori* arguments, attention to the last constitutive in the triad of 'matter – energy – information' will come to the fore. Properly, the question is whether information is a significant factor in evolutionary processes or if matter and energy are alone sufficient.

In a strict physicalist version, evolutionary mega-trends in the Universe are nothing but an irreversible growth of entropy in which the emergence of qualitatively higher organizations like life and society serve to accelerate the destructive processes (Huzen 2000). A moderate physicalist view, which is more popular among scientists insofar as it denies a creative role to intellectual agents, also leads us to the conclusion that the prospect of civilization is strictly constrained by natural laws (Nazaretyan 2004).

It is not an accident that interdisciplinary scholar David Christian follows the professional astrophysicists' usual estimation of the distant future. Entities as complex as modern human society, he suggests, arise close to the limit of our Universe's capacity to generate complexity, and so we cannot expect dramatic further development. After the Universe's youthful period ends, stars will flicker out and die, the Universe will get colder and colder as it ages, and there will be no more energy to conjure up or sustain such miracles as living and thinking matter. Apparently, this textbook scenario is a slightly modified wording of the heat-death theory (see a similar scenario in Spier 2010).

In Russia, the influence of Cosmist philosophy remains strong among many of the most qualified astrophysicists and mathematicians, including those who actually work outside of Russia. We find its influence even extending to those who reject its naturalist scenario but still relate the potential future of the Metagalaxy with the increasing intervention of civilization (Novikov 1988; Linde 1990; Lefevre 1996). Not only Russian physicists come to similar suggestions, but also others. For instance, the eminent American specialist in quantum theory, David Deutsch (1997), who seems to had never heard of Cosmist philosophers, distinctly expressed the same idea: The future story of the Universe depends on the future story of intelligence, which will progressively enhance its control over cosmic space as completely as it is dominating the Earth's biosphere (see also Nazaretyan 2010b).

Although this suggestion looks amazing on the surface, it becomes reasonable when we observe the long trend over billions of years. Looking back, first at the millennia of social history, we note how 'virtual' events like novel ideas and values, religious and philosophical doctrines, poetic, artistic and musical images, technological and scientific findings, all have exerted – via human activities – stronger and stronger impacts upon the Earth. Ultimately, their far-reaching effects surpassed the ones of spontaneous geological and climatic cataclysms full of blind power.

Going back far beyond human history, we again find that living matter's growing capacity to use energy flows is related to its growing 'cleverness', although in this case the fact is less obvious. To argue it, Vernadsky has used the concept of a 'coefficient of cephalization' – the anatomic correlate for the intellectual quotient of vertebrate species. If we take modern fauna's aggregative index for 1, then the index for the Miocene (25 million years ago) would be 0.5 and for the beginning of the Cenozoic (67 million years ago) would equal 0.25. This outstanding Russian evolutionist did not read the words by Norbert Weiner (they were written after Vernadsky's death in 1945), but he was also puzzled by numerous facts that demonstrated the independent role of information: How can mind, which is surely not a form of energy, influence material processes?

We will consider some approaches to this question. As to the *growing* capacity of intelligence-induced regulation, modern Psychology offers some suggestions. As gestalt-psychological experiments have shown, parameters of the objective situation, which are *uncontrollable constants* within an accepted mental pattern, prove to be *controllable variables* as soon as we find a conceptual meta-system to reflect more extensional causal links. Having assumed our world is infinitely complicated, no absolutely control-proof attributes of it should be theoretically imposed, and no correctly formulated technical problem should be recognized as radically solution-proof.

In fact, the history of the development of social technologies shows us that any major problem has been resolved as evolution required it. Most technical achievements in the 20th century seemed to be theoretically forbidden by the natural laws of the 19th century. Indeed, the outstanding thinkers of that earlier age did formulate worthy interdictions against the possibilities of these new advances. Although no law of classical Physics had been dramatically disavowed, multiple additions, modified definitions, and specifications made possible quite a different conceptual and technological reality. Looking further back in human history, or into the evolution of pre-human biological 'technologies' (living matter's expansion from the sea onto land, conquest of the air by vertebrates, *etc.*), we find a slower but essentially similar succession.

The post-physicalist view of Big History's empirical evidence supplements the evolutionary portrayal with a new determinant. The relationship between

structural complexity and the amount of energy consumed has been brilliantly shown by Eric Chaisson (2001): The more complex the order is, the denser the energy flows that pass through it. Our caveat to this principle is that the denser energy flows take place because complex systems get 'cleverer' and thus perfect their control capacities. The relationship between a system's capacity for energy control and the volume of its information has been singled out as 'one of the fundamental laws of nature' by Russian system theorists (Druzhinin and Kontorov 1976; Nazaretyan 1991).

It has also been indicated that as soon as we include the information-control parameter, the *futuribles* (potential futures) of civilization, as well as that of the Metagalaxy, look radically different. This is related to the various perspectives of the mind's development. The cosmic Universe can be influenced by intellectual development of the Earth's civilization (if it survives) or some other planet's civilizations, which manage to survive longer. This raises specific problems, including ethical ones (Nazaretyan 2010a, 2010b).

The differences between adherents of the *a posteriori*, experiential approach admit to having a scientific debate about the Universe's patterns. In contrast, the discrepancies between the *a posteriori* and the *a priori* (teleological; theological) approaches are mainly a subject of 'philosophy', which being 'eternal' questions, cannot be solved by the scientific method. As far as post-classical, model-oriented epistemology excludes final and exhaustive solutions, gaps in any theoretical worldview may be filled by an appeal to the purposeful (and thus anthropomorphic) Actor. This mocking phantom is perpetually soaring over science and evolving together with it from the Biblical Creator to the Watch-Master, and further, to the Computer Engineer, Exo-Planet or even Exo-Galaxy Intellect, and so on, to create complementary impulses to scientific and philosophical reflection.

Nevertheless, as we have mentioned, modern scientific method accepts a telic approach as much as it is introduced in the context of actual interactions (the task of preservation). Taking this into account, we will conclude the article by a brief outline of one of the synthetic patterns that helps us to interpret Big History's mega-trends.

Big History, Cybernetics, and Self-organization Theory

The mutual relationship of causal and telic mentalities has had its own faraway and fanciful story, and has essentially influenced both official ideologies and ordinary worldviews in various epochs (Nazaretyan 1991). Non-classical science implies a synthesis of approaches that is embodied in the interdisciplinary patterns of cybernetic system theory and synergetics.[5]

[5] Self-organization patterns were named *synergetic* in Germany (H. Huken), *non-equilibrium thermodynamics*, or *theory of dissipative structures* in Belgium (I. Prigogine), *theory of autopoesis*

In cybernetics, the goal is considered to be the 'system-making factor' (Anokhin 1974). The primary kinds of goal for interacting systems is not a final condition but conservation of the parameters of all outer and inner structures. Combination of the two basic attributes – immanent activity of matter and physical conservation laws – is manifested in 'the struggle of organization forms' (Bogdanov 1996), or *competition of controls* for preservation of current movement condition by each of the interacting agents.

Some patterns of classical Physics, such as variational principles and Onsager Law, organically conform to the metaphor of regulation, control, telic causality and competition. Ultimately, as the Russian physicist Nikita Moiseev put it: 'Any inert matter law ... is in fact a mechanism of selection of real movements' (Moiseev 1986: 70).

The cybernetic and ecological metaphors put together the questions beginning with 'why?', 'how?' and 'for what?' Molecular biologists are aware that ferment synthesis, at any particular moment, is regulated by the cell's actual needs. Geologists apply telic functions in order to mathematically describe landscape processes. Having asked for what purpose nature needs several kinds of neutrino or lambda-hyperons, theoretical physicists refer to system-dependencies. The search for the 'missing elements' has more than once led to important discoveries. Conceptions based on categories like control, self-organization, competition and selection demonstrate continuity between 'inert' and living matter, the evolutionary roots of apparently aim-oriented behavior by living organisms.

In particular, cybernetic system theory accentuated the functional essence of material *reflection*. As Russian chemist and philosopher Yuri Zhdanov has indicated: 'Self-preservation against outside coercions is an essential function of reflection as an immanent material faculty' (Zhdanov 1983: 73). Compare this to Prigogine's words about 'blind equilibrium'. Therefore, the philosophical category of *reflection* is similar to the interdisciplinary category of *modeling* as an instrument of control.

Provided all interaction agents have comparable capacities of reflection and control, the outcome is a kind of 'compromise of coercions'. Still, even in this case, equilibrium conditions are only a virtual aspect of non-linear processes (like a perfect gas or a geometric point).

Since self-organization effects have been discovered, we can better understand how a highly improbable, far-from-equilibrium condition spontaneously emerges. The combination of self-organization and control patterns makes it clear why a non-equilibrium condition is preferable and purposefully defended

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in Chile (U. Maturana), *dynamic chaos theory* in USA (M. Feigenbaum), and *non-linear dynamic* in Russia (S. Kurdyumov). Recently, a general term, *complexity theory*, has become popular. The linguistic diversity and competition for priority must not conceal the fact that these are various readings of a single scientific paradigm.

by complex systems. We see why feedback and modeling mechanisms have been progressively improving together with structures' complexity and behavior capacities for billions of years (Nazaretyan 1991, 2004).

In the 1940s, Erwin Schrödinger showed that anti-entropy work can be done only by means of 'order consumption' from outside – at the cost of the increasing entropy of other systems (Schrödinger 1969). When and if the environment is abundant, open non-equilibrium systems increase the volume of their anti-entropy work, and expand as much as they can. Sooner or later, this exhausts the available resources, and, as a result, a specific crisis in system-environment relations follows.

Crises of this type are called *endo-exogenous* in ecology. The system – an individual, a population or a human society – runs up against unfavorable environmental transformations provoked by its own activity. Endo-exogenous crises, including all of the anthropogenic (technogenic) ones, play a special role in evolution. As previous anti-entropy mechanisms turn counter-productive – being fraught with catastrophic entropy growth – a bifurcation phase develops. If migration is impossible, there are only two further possibilities. Either the system returns to equilibrium – it degrades (what is called a *simple attractor* in synergetics) – or it diverges, owing to the development of advanced anti-entropy mechanisms. The latter is usually caused by a higher inner diversity and structural complexity, resulting in a more dynamic model with higher resolving power and sensible feedback mechanisms.

The new, non-equilibrium response to crisis is known as a *strange attractor* (Arnold 1992). It looks like a 'quasi-aim' situation, since the actual self-preservation task has turned with directionality to a phase transition (a qualitative leap). Indeed, a highly developed society can give this crisis-coping effort deliberate projects that result in technological, organizational and psychological reconstruction. Retrospectively, the sequence of successful solutions that are accompanied by dramatic collapses, over a long passage of time, is seen as overall biological and social 'progress'.

Self-organization patterns in anthropology include the evolution of spiritual culture, which is usually mediated by anthropogenic crises. It has been shown, for example, that instrumental intelligence, like any other anti-entropy vehicle, led early hominids into dangerous situations: The Olduvai artifacts broke the ethological balance between animals' natural weapons and instinctive intra-species aggression-inhibition (Lorenz 1981). Stone weapons came to supplement muscle and teeth. In this new and unnatural situation, in which the proportion of intra-group deadly conflicts became incompatible with existence, perhaps very few *Homo habilis* groups could have survived.

Archeological, anthropological and neuropsychological data on confrontation brings us to the conclusion that hominid survival was due to specific neu-

rotic condition. Necrophobia (fear of the dead) seems to have been the first artificial factor that balanced the killing-power of extra-natural weapons: It restrained in-herd aggression. Necrophobia was displayed in the care for their dead, sick and crippled conspecifies. So, the groups affected by necrophobia, which implied higher mental lability, suggestibility and unnaturally developed imagination, were the ones to create proto-culture and start a new evolutionary spire with different selection mechanisms (Nazaretyan 2005).

Since that time, the existence of hominids, including *Homo sapiens*, has not followed a natural course but has, to a great extent, been enabled by the balancing of technological power through cultural regulation. Disparities in the development of instrumental and self-regulative hypostases of culture caused outbursts of ecological and/or geopolitical aggression, which most often resulted in the destruction of society. The mechanism by which internally sustainable social systems are selected and unbalanced ones – discarded has so far enabled the preservation of humankind. As calculations show, although killing power of weapons and demographic densities have been successively growing for millennia, the ratio of human killings to population numbers has been non-linearly decreasing (Nazaretyan 2008, 2009, 2010a).

Those calculations (and some others) have been conducted to check a corollary of the hypothesis, which arises from quite different empirical evidence, namely, the history of anthropogenic catastrophes and the following cultural revolutions since the Paleolithic. Summing up diverse information from cultural Anthropology, History, historical Psychology and current Ecology concerning anthropogenic crises, I suggest that there was a regular relationship between three variables: technological potential, cultural regulation quality, and society's internal sustainability. This pattern is called *The Law of Techno-Humanitarian Balance: The higher the power of production and war technologies, the more developed behavior/regulation means are required for self-preservation of society*.

Following this pattern, we can observe the progression of pan-human history, in spite of successive and dramatic replacement of leading cultures and continents. We see how one after another social organism fell into evolutionary deadlock, but humanity as a whole managed to find a way out. This was achieved by successive and irreversible leaps forward that included technological innovations, increasing information volume of the individual and social mind, complexity of social structures, and improvement of cultural values.[6]

[6] The hypothesis for Techno-Humanitarian Balance is consonant with Lawrence Kohlberg's (1984) idea of the correlation between humankind's intellectual and moral development, which is still a subject of criticism, even by social evolutionists. In fact, Kohlberg applies classical evidence by Jean Piaget and his followers concerning individual development to social history, as well as the 'conflict-enculturation hypothesis' of anthropologists: the downward course of violence with

Seven wide-ranging anthropogenic crises and their resultant revolutions since the Lower Paleolithic have been considered. Each solution led to the next growth phase of the social system. On the whole, this process led to the distancing of society (the society/nature system) from the natural (wild) condition. This becomes clearer when we contrast, for example, hunting-gathering to agriculture (Neolithic Revolution) or farming to industry (Industrial Revolution), or industry to modern information economy (Information Revolution). Each of the revolutions broadened and deepened the human ecological niche, as well as furnished a new demographic transformation, new opportunities, new ambitions and new consumer demands. It thus led to overall improvement until a subsequent anthropogenic crisis began.

In synergetic (complexity theory) terms, human history is the story of one 'self-similar' system that exists on the scale of a couple of million years and has been successively transforming itself to conserve sustainability (Christian 1991, 2004). From there, we may see the universal roots of human intelligence and morality without appeal to 'God's Providence'. What we call biological or social 'progress' is neither an eternal purpose (a divine program) nor a movement 'from worse to better'. It is *a means of self-preservation* by which a complex, far-from-equilibrium system responds to the challenges of reduced sustainability and to the effects of its own chain of successful adaptations.

Thus, the informational parameters of world development bring a relevant 'moral' or self-regulation view to the evolutionary stage. Taking a bird's eye view of World History along with the context of Big History helps us to develop reliable scenarios for the future and distinguish between forecasts and projects that are realistic *versus* those that are utopian. Hence, planetary civilization's prospects in the 21st 'bifurcation century' are concerned either with a global fracture or a next drastic 'digression from the natural condition' spiral. This conclusion, which is based on long-term historical observations and analysis of relevant mechanisms, discredits numerous 'back to nature' claims and projects. The creativity of the mind gives civilization unlimited potential for advancement, but the mind's inner imbalance rather than natural laws may turn with lethal menace on civilization in the future (Nazaretyan 2010b).

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increasing time has been revealed both in Western and primitive cultures (Chick 1998; Munroe *et al.* 2000).

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