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**SELF-REGULATION WITHIN BIG HISTORY AND CYBERNETIC REVOLUTION.**

Big History is a multi-disciplinary concept which examines history from the Big Bang to the present. Many processes around us depend on universal phenomena, we think self-regulating systems are some of the most important among them.

In this paper, we are going to present some examples of self-regulation in the Big History.

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**What is self-regulation?**

**Self-regulation is a system's ability to maintain and/or adapt its status to changing conditions.**

Self-regulation has different levels of development.

For simplicity, in this paper we will be concerned with:

1) simple self-regulating systems

2) complex self-regulating systems

3) and intelligent self-regulating systems.

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So, let us look at some examples of self-regulation.

One of them is a coffee machine which can turn on automatically at a certain time and keep coffee hot as long as needed. It is an example of а simple self-regulating system.

The machine which can organize purchasing, delivery, grinding and preparation of coffee will be an example of complex self-regulating system.

Navigator is an example of a rather complex self-regulating system. It cannot drive the car by itself yet, but it chooses the best route, monitors and analyses many parameters, and guides the driver who only has to steer.

An automobile which will prevent the person from driving if he is drunk and, on his own will deliver him home, is an example of an intelligent self-regulating system.

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 In a developed self-regulating system there can be a special control center which specializes in self-regulation. Such division of functions helps systems significantly reduce energy consumption. For example, in the self-regulating systems of living organisms, the formation of a nervous system, the main function of which is regulation, gave a great impetus to evolutionary development.

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**Self-regulation and Big History**

Let us briefly review the importance of self-regulation at some levels of Big History.

**Self-regulation in stars.**

Stars can maintain their energetic balance for billions of years due to their self-regulating mechanisms. For example, when a star is out of energy it can produce more energy by self-compressing or by the amplification of nuclear processes.

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Galaxies also are self-regulating systems. The life-cycle of stars is repeated over and over -- although never exactly the same: dispersed gas collapses, which leads to star formation, which leads to energy injection from supernovae, which disperses the gas once again.Besides, as a result of these outbursts, the products of fusion synthesis are released. That’s how the Universe as a whole, and each galaxy in particular, are evolving chemically.

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**Life on Earth.**

Undoubtedly, life is a very complex self-regulating system. Many factors contributed to the emergence of life.

One of the main factors is the origin of self-replicating molecules. It is the RNA molecule which is supposed to have such an ability. As a result of laboratory tests, it was demonstrated that in the mixture which did not contain RNA, but contained only its components, under certain conditions self-replicating RNA can spontaneously emerge. At the same time, RNA is capable not only of self-replication but also of evolution. During the lab experiment, ethidium bromide, which inhibits the RNA synthesis, was added. At first the formation of RNA was inhibited, but after nine ‘in vitro generations’ of evolution, the new RNA strain, resistant to toxin, was developed.

RNA molecules contain a code system, which is another important factor of life. All information of the organism is encoded in the genes.

But genes are another example of self-regulating systems. For instance, there are gene-controllers, which can turn on or off the expression of the DNA .

As shown in the image, DNA transcription depends on which regulatory factor is working at that particular time.

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And if there are broken genes after the expression, special proteins check them and cut them off, preventing unnecessary mutations.

In the image we can see the special enzyme - DNA ligase, during the process of repairing chromosomal damage. It joins broken nucleotides together. This is a very promising method to treat many diseases.

The next important factor of life, is homeostasis.

Over 4 billion years ago, chemical elements were surrounded by the lipid bubbles, called *coacervates*, which produce isolated, complex self-regulating systems. That is how a living cell first appeared.

**Thresholds and technological breakthroughs.**

The origin of humans was a huge step during the next threshold. It was connected with the development of the brain, which surely is the most complex self-regulating system in nature. The origin of language which is also a complex self-regulating system facilitated collective learning.

According to our concept, the entire historical progress can be divided into three production revolutions. Production revolutions are fundamental technological breakthroughs that change the whole structure of society and the way of life.

These production revolutions are related to the following Big History thresholds:

1. the Agrarian Revolution is related to the Agricultural Threshold;

As a result of the Agrarian Revolution the ancient demographic revolution occurred. It happened because new technologies allowed people to produce more food. Population grew and formed new self-regulating political systems such as tribes, communities, chiefdoms, and later states. Democracy actually also used to be a self-regulating system.

2) The Industrial Revolution is related to the Modern Revolution Threshold; During this time a lot of technologies were invented, developed and automated. Most of them became simple self-regulating systems.

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3) And the newest one, the Cybernetic Revolution, which began in the 1950s, and its final phase will start in the 2030s. The Cybernetic Revolution is related to the Future Threshold.

 We call this revolution a ‘Cybernetic’ one because self-regulating systems will play a key role in this revolution. As we know, Cybernetics is an approach for exploring regulatory systems, their structures, constraints, and possibilities.

 Self-regulating systems will become the main trend of the newest technological developments, which will significantly change our life and prolong it up to 100 years or more.

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We think that forthcoming technological breakthroughs will start in medicine, which will connect additive technology, nanotechnology, biotechnology, robotics, information and cognitive technologies. We denote it a MANBRIC complex.

Since we are limited in time, we will briefly discuss only some of the future self-regulating systems and technologies which will change our lives. We will consider their present and future development during the next decades.

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**Comprehensive health monitoring and artificial immune systems**

**Today** there are many devices, which can monitor different parameters of the organism like pulse, blood pressure, sugar level and many others. Some of such devices are sosmall, that they can be inserted into a cell. Some devices have GPS module and can contact the nearest emergency center if necessary. Last year Google announced a semi-secret project of so-called nanobots – the nanostructures, which function in human blood and monitor various parameters. Nanobots are swallowed as a pill, and due to their magnetic properties may be collected together and withdrawn from the body at any time.

We suppose that **in three to four** **decades** such systems will be able to constantly monitor hundreds of parameters. These microscopic and very complex self-regulating systems will form an artificial immune system. It will help the natural immunity and will allow access to every cell of an organism. The artificial immune system will be able to neutralize pathogens, cancer cells, control drug assimilation. Probably, it will be also be capable of simple genetic manipulations.

**A brain–computer interface (BCI)** is a direct communication pathway between brain and an external device.

**Today** BCIs are widely used, especially in medicine. For example, in artificial visual systems or bionics. The most notable device is the cochlear implant, which has been implanted in more than 220,000 people worldwide.

Brain-computer interface development generates tremendous excitement in scientists and the general public.

Thus, **in three to four decades,** disabled people will get another chance in life. BCIs may improve rehabilitation for people with strokes, head trauma, and other disorders. Those who can pay and want to increase their abilities will be able to replace their body parts with bionic ones.

Also in three to four decades,small on-head electrodes will make remote brain control possible. So people will be able to turn TV on only by thinking about it.

**Robots**

Another good example of self-regulating systems are robots which are likely to become very common in the consumer sector.

Robots already exist which are capable of performing simple tasks which are not preprogrammed.

**In three to four** **decades,** robots will be able to change their program code by themselves if needed or to find necessary solutions in the Internet of Things. These will be very complex self-regulating systems. The development of robotics will be closely related to the progress in artificial intelligence, which will facilitate the development of intelligent self-regulating systems.

Robots will increase efficiency in many sectors. For example, in medicine they even can replace doctors and perform different surgeries without human interventions.

**Smart devices**

Everyday technologies become more self-regulating, complicated, and more intelligent. It is even clear from their names. The word “smart” is used as a prefix to many devices.

Today smartphones have become ubiquitous, while smartwatches are becoming popular, people watch smart TV, and in schools they use smartboards. Google, Tesla and other companies already have announced development of smart, self-driving cars.

We assume that this trend will continue and thus, **in three to four** **decades** the majority of everyday devices will be smart. An absolute majority of them will connect to the smartphone and Internet. All information about how much you walk, how long you sleep, how much money you spend, how much fuel is left in your vehicle, and many other things will be displayed on your mobile phone screen. We will live in smart homes with smart kitchens, while a smart climate control system will maintain the required temperature 24 hours a day.

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So, why is self-regulation so important? We consider that self-regulation is a universal phenomena and is closely connected with Big History. Self-regulation has become very complex in some systems, especially in biological ones. We suppose that self-regulation will be the main trend of the forthcoming Cybernetic revolution. This will be a world of complex and intelligent self-regulating systems that can bring us to the ‘post-human’ era and dramatically change the society and our way of life. It also means that humanity and Big History itself are at the top level of evolution and probably are close to the bifurcation point or perhaps, to singularity.

It is very important to understand how self-regulation develops. It can help us to make some predictions and to anticipate the side effects and risks of the coming technological revolution.