

Introduction

Between Human and Post-Human Revolutions or What Future is Awaiting Us?

In the modern world an individual deals with different technologies and products of scientific and technological progress and becomes more and more dependent on them, spending considerable time to understand changes and to keep up with progress. In general, the entire human history especially in the last few centuries is the history of victories and triumph of science, technology, and information technologies. Moreover, the humankind being a father of technology at the same time became more and more dependent on it. Today technologies penetrate almost every aspect of our life: private, family and intimate, as well as our mentality. But even more serious transformations are awaiting us in the future when devices and technologies are introduced into the human body and consciousness thus putting strain on all our biological (nervous, physical, and intellectual) adaptive capacities. Today they give a serious thought to seemingly strange ideas about whether mobile phones, computers, and organizers can become a part of our body and brain. In fact, technology has become one of the most powerful forces of development.

The changes occurring within the society are very often caused by technological transformations. That is why the issues of technological development appeal to our contemporaries. So it is extremely important to reveal some regularity in the history of technological development, and make an effort to anticipate at least the coming transformations in technologies and in the society. But, unfortunately, there are quite a few researches which in a systemic and consistent way describe the technological development and can explain in scientific terms why and how the technological revolutions occur. Besides, there are also quite a few works that present a consistent forecast of technological development proceeding from the discovered developmental trends.

Our study is devoted to the history of development of engineering and technology, to the analysis of their current state and reflections about their future. In this book we pay attention to the main technological revolutions in

the history of human society, both to those already completed and to the future ones, as well as to the transformations in society and consciousness they have already brought and will cause in the future.

In the 1950s and 1960s the world (first of all, the developed countries) witnessed the largest technological revolution which continues until the present. At the end of the twentieth century the achievements of this revolution especially in the field of information technologies have become widely spread in the most countries of the world. This revolution is variously termed (scientific-technological, information, *etc.*). However, we denote this revolution as the *Cybernetic Revolution* since cybernetics is the science about information and its transformations in the process of regulating various complex systems. The current revolution has dramatically changed the information processing as well as promoted a breakthrough in the regulation of complex processes in a wide range of natural and artificial systems that have become a part of production process (and in the future it is likely to trigger such a breakthrough to the full scale by creating an essentially new environment, *i.e.* a world of self-regulating systems).

The Cybernetic Revolution is the third largest production revolution in the history of humankind following the Agrarian (Neolithic) and Industrial ones; yet, it has not finished yet. In this volume we discuss the revolutionary changes which the world will face in the coming six–seven decades within the ongoing Cybernetic Revolution. The coming phase of the Cybernetic Revolution will change the quality of our life by enhancing the impact on human body. There will also appear technologies that will allow different systems to function in a necessary regime without direct human intervention (*i.e.* these systems will become autonomous and self-regulated). The capability to maintain the given parameters in self-supporting (autonomous, self-regulated) regime will involve the control of production and information that has already become possible in various spheres during the decades of the Cybernetic Revolution, as well as control of a number of technological, social, natural, and especially biological processes (as well as in the human body).

Earlier they used to connect the emergence of *Homo sapiens* with new technologies (arguing that labour transformed apes into humans, while the labour implied first of all the ‘production’ of stone tools). Now it is clear that it was the result of a range of reasons which changed human genetics, though the material factors (such as the way of life and natural environment) also enormously contributed to this process. The transition to *Homo sapiens* is termed the *Human revolution* (*e.g.*, Mellars and Stringer 1989), yet we would better denote it as *Proto-production* revolution with account of its im-

pact on the society since it triggered quite a rapid development of technology proper (what is more, technology developed in different spheres including also the primitive painting).

Today we are at the threshold of the Post-human revolution. Perhaps, it will be less dramatic than the transhumanists and other adherents of practical immortality imagine it in a wish to part with the biological body. But anyway we are speaking about considerable extension of life, increasingly common replacement of organs and cells of the human body with non-biological materials, introducing of electronic and other (nano-, *etc.*) elements into the human body for rehabilitation or improvement of individual functionality, and systematic influence on genome. On the whole, quite dramatic changes are upcoming.

Thus, figuratively speaking, our research lies at the intersection of Human (or Upper Paleolithic) revolution and the new 'post-human' revolution whose consequences are unclear in many respects but which will obviously start the era of an intensive impact on human body.

Between Technological Optimism and Reasonable Caution

In our book basing on the studies of the whole previous technological development we try to outline the direction and logic of further technological progress, as well as to describe the future which is already knocking at our door. In the chapters devoted to current and future changes we will pay much attention to the analysis of the features that will manifest in technologies and to what we can expect from them. But we would not like the reader to think that the authors estimate every change described in the book only in a positive and optimistic way.

Futurologists can be divided into impetuous optimists, alarmist, and careful optimists, the latter calling to think in advance of the negative consequences without disregarding progress. We belong to the third category and think that we should not be afraid of the future. However, one can hardly expect that the future will be definitely better than the present, and moreover, in every aspect. The stakes are always high.

Indeed, the achievements being a solution to problems can also cause them and even at a larger scale, thus, contributing to the increasing dependence. Besides, in the future there will appear many problems resulting from the change of the habitual way of life.

It is difficult and actually senseless to try to impede progress. However, there is always a question of what one should consider as a progress at every particular epoch and what the costs are. Anyway, it is better not to rush

into changes with vague consequences. When treading new ground, it is better to be careful than to rush. Science, innovations, and changes rapidly drive a lot of new legal, moral, and economic problems and cause sharp disputes, conflicts, trade wars, and phobias. The public consciousness definitely lags behind. The uncontrollable technological progress can be compared with the Roc, the legendary bird from the Arabian Nights that quickly carries the humankind but demands human sacrifice. Are we ready for it? Meanwhile, what we are ready to sacrifice for the sake of progress is one of the most important issues.

One may ask: why discuss the dangers today if they are still longshot? The thing is that future can turn out quite unexpected and even terrible. Thus, one should anticipate and think of it in advance. Anyway, it is necessary to speak about it since there are numerous threats whose number increases in a geometric progression due to the accelerating changes, the same way as a higher speed increases the likelihood of an accident (see also the final part of Appendix 2).

The development usually starts with euphoria from implementation of new tools or knowledge and only much later there comes an understanding of pressing problems which they bring, and finally, the restrictive measures are taken on their application to reduce the revealed negative consequences. However, it is much better to change this sequence and even to find legal and appropriate restrictions before implementation.

In Anticipation of Dramatic Changes in Evolution and Human Nature

Many researchers suppose that we have been moving towards some quite considerable transformations and that in the next decades, human civilization will experience dramatic changes. Some speak about approaching the singularity point as a certain unprecedented level of development (yet singularity is a mathematical notion and not social or evolutionary one), after which a new phase of development of human and nature will start¹ (here we should especially point out Raymond Kurzweil's works, *e.g.*: Kurzweil 2005, which we can evaluate as a boundless technological optimism lacking sufficient scientific grounding). And this perception of dramatic changes is quite natural. We also believe that in the 2030–2040s the world will enter an epoch of significant and even dramatic changes. However, contrary to other researchers, we argue that this will be an expected result of previous

¹ For more details about views on singularity see Grinin L. and Grinin A. 2015: 11; see also: Tsirel 2014; see the comment in Appendix 2 in connection with the citation in Dyakonov 1999: 348.

development of society and especially of technologies. Thus, the driving forces of the future changes are by no means mysterious or unique. And still there are many disturbing things... One should realize that these changes in human development not only provide new opportunities, but also conceal serious risks which must be anticipated.

In the end of the twentieth and early twenty-first centuries there will be widely spread an idea of a possible or even inevitable transition of humankind to a new biological form in the near future. What does it mean and what consequences will it have? Is it possible to change this line or does it realize any exceptionally challenging evolutionary trends? It is extremely difficult to answer these questions especially since they are inherently ideologized and turned into a kind of religion whose main postulate is the future immortality of every individual.

In brief, today the focus is on the increasing opportunities of changing the human nature. Consequently, the question is what is the human nature itself and to what extent can it be modified? We think that Francis Fukuyama has thoroughly analyzed this issue in his *Our Post-human Future* (Fukuyama 2002) and thus, there is no need to consider it in our research. In his opinion, *human nature is a set of behaviors and properties typical for a human as a species and arising from genetic backgrounds, but not factors of environment* (Fukuyama 2002). However, he often expressed the idea that human rights can be derived from the biological nature to prove the advantages of democratic political regimes over others. We find this approach rather disputable.

We would also like to emphasize that fifteen years have passed since Fukuyama wrote his book and today the issue is much more pressing. There exist different philosophic approaches concerning humans as a social species, but today the topical matter is the human biological nature not in philosophical terms but in a concrete medical and biological sense. The emergence of artificial organs and cells has already brought about the issue of human material and biological nature, namely: what matter will a future human be made of – natural biological or artificially made biological substance or will it be a non-biological being at all? How will humans reproduce? How will the brain and consciousness operate? Any change will dramatically alter human fundamental institutions including morals and interpersonal relations. Indeed, what will become of morals and what will it be if the matter concerns the change in the biological nature? Morals and human relations do not exist separately from technologies, all the more from human physiology and, and in a broader sense, from the biological basis. It is a result of complex sociobiolog-

ical evolution, and morals can disappear after losing its material biopsychic shell.

From Human to Cyborg?

Already at the end of the last century it became clear that the opportunities to influence human genotype can generate a lot of complicated and dramatic social, political, ethic, and legal problems in the future. One should note that bioethics became a response to these future (and already emerging) dangers. Of course, this society's response has no serious implications, but after all it was meaningful. Fukuyama gives a rather detailed list of the dangers. In particular, he mentions the increasing opportunities to regulate human behavior (here he emphasizes that neuromediators made it possible already in the end of the last century), the emergence of genetic castes, classes or social strata since changing of genetic qualities can heavily depend on parents' wealth; otherwise, a more egalitarian society in terms of genetics will appear (in case of obligatory correction).² In fact, the attempt to improve human moral nature by means of genetic modifications seems rather dangerous. In this context the reduced diversity can significantly weaken society and its ability to respond to challenges.

However, so far we have hardly touched new and to some extent more serious threats that have recently appeared. Let us consider some of them.

It has already been mentioned that the pace of scientific and technological progress generally continues to speed up. The historical process is also gearing up while neither individual, nor public consciousness is able to keep up with it. This brings heavy collisions and frustrations, and moreover, it arouses a quite reasonable alarm about our future, and it is not about social, but about physiological and biological future since the number of people increases who wish to refuse it and to put the brain and consciousness into an abiotic immortal body (made of iron, plastic or other material). Will humans turn into cyborgs, as a result of the rapidly developing directions of bionanotechnology and cognitive sciences? It is not an idle or innocent matter at all, especially with the account of the increasing number of prophets of 'avatarization'³ who bravely (and without thinking) appeal to discard the perishable biological body.

² These fears have not decreased since then; on the contrary, the number of opponents of genetic modifications has grown, and their arguments became more convincing. At the same time it seems that the practical modification of human embryos has already started. Thus, in April 2015 China declared about the conducted work on modification of the human embryo (Field 2015).

³ Avatar is the term used in Hinduism philosophy to denote the terrestrial embodiments of God (especially Vishnu). Respectively this term is used by some supporters of coming human immortali-

How much truth is there? Actually, on the one hand, medicine has been moving in this direction for many decades and it has learnt to make false teeth, connective tissues, bodies, to replace sense organs with devices, and to create life support systems (hearts, lungs, kidneys, *etc.*), not to mention the production of artificial preparations (drugs) causing reactions similar to those resulting from the activity of endocrine glands, impulses of the brain or work of internals. Currently, bioprinters have been actively developed and they can create these or those organs; there are also neural interfaces (or brain–computer interfaces) permitting to operate some facilities, devices and equipment ‘by force of thought’ through biological currents and micro-electronics (see more details in Chs. 3 and 6). Undoubtedly, the opportunities for creating organs, tissues and fractions from artificial non-biological materials will considerably increase in the future. All this contributes to the transformation of the human body into a kind of cyborg. Besides, this increases a certain oncoming traffic of technologies in terms of rapprochement of people and artificial smart systems, in particular in the construction of humanoids. These robots will be employed not only as workers, but also in very close or even intimate contacts with people (*e.g.*, they can be used for sexual services, or as companions, *etc.*). Then the borders between the human and artificial anthropomorphous systems are likely to dissolve.⁴ Besides, modern information technologies already create a virtual environment where it becomes more difficult to distinguish reality from illusion; to say nothing of use of modern bio, cognitive and robotic technologies for military purposes.

But, on the other hand, any simplified ideas of human body and, all the more, brain and consciousness are extremely dangerous (similar to the dangerous use of brain at the level of electronic device). Millions of years of biological evolution have made all constituents of biological organisms and their functions optimal, interconnected, and sensitive to changes at any part of the body so that any interference with physiology, and all the more, the brain, has to be thought over many times to prevent possible damage. Even the slightest knowledge of biology makes it clear that human brain cannot work without

ty to determine the transformation of the human spirit (brain and consciousness) into the new (non-biological) body.

⁴ Let us note that the production of sexual robots (generally ‘female’, so far) has already started. There were also statements that by the middle of the century such contacts between humans and robots will become commonplace. Not without reason a campaign for their prohibition has been initiated (see Griffin 2015). However, so far these requirements come from the feminists who are concerned with such a detraction of the female role, but we agree with them. It is better to forbid or to take under control this situation in advance, because if businessmen have a chance, sex robots for any sexual orientation might appear.

body since its main function is to accept signals from the body and to transfer them. Thus, any ideas that consciousness can be somehow 'transplanted' are a rough and ignorant imagination. Therefore, the process of cyborgization can never go too far, it will always remain 'supplementary' for the biological component of organism and it can considerably improve quality of life as well as to prolong it.

Today the scientists learn to create artificial biological tissues and bodies by means of stem cells or other biotechnologies. We suppose that this way of 'repairing' our body will be more promising. For example, at present, we know some cases when a person was replaced heart six times (and once a kidney) during his life. This is a multi-millionaire David Rockefeller Sr. who has undergone the last operation on heart transplantation at the age of 99. But now only a multi-millionaire can afford it (and nevertheless, he is really lucky). However, in the future it will be possible 'to repair' many people by means of laboratory-grown organs. But, undoubtedly, this biological interference into human body has both physiological and social restrictions. The interference with human genetics can also cause serious problems, especially if used for creation of individuals with superhuman potential, for example, for sports records. Nowadays, as we know, sports organizations fight against using medical and pharmaceutical achievements for gaining advantages. In this context, it would be better to avoid the emergence of genetic control over athletes, but still there exists such an opportunity. Thus, hopefully it will become possible to prevent reckless interference with human body regardless of its motives: whether it is aspiration for scientific fame or profit or realization of the superman ideology. While welcoming the scientific and technological progress, we consider that we should preserve our biological heritage that has been created over millions of years.

The Structure of the Book

In **the first chapter** of the monograph the authors describe the main technological changes. The description covers almost the entire period of social evolution starting from the emergence of *Homo sapiens* up to the mid-twentieth century when the Cybernetic Revolution began. We did not point out every considerable invention or separate innovations in detail instead we made an attempt to show the general process of changes and to explain how and why technological epochs succeeded each other.

In **the second chapter** we describe the main characteristics of the Cybernetic Revolution, which we already can observe, yet they will be implemented in mature and mass forms only in the future. Of utmost importance is the fact that the self-regulating systems will become the major part of

technological process. That is the reason why we denote the final (forthcoming) phase of the Cybernetic Revolution as the epoch of self-regulating systems. The self-regulating systems are systems which can regulate themselves by means of the embedded programs and smart components, responding in a pre-programmed and intelligent way to the feedback from the environment as well as operate independently in a wide range of situations, having opportunities for choosing optimum regimes in the context of certain goals and tasks. These are systems that operate with minimal to zero human intervention. In the second chapter we also discuss the logic of the Cybernetic Revolution, which gives us opportunity to forecast the duration of the intermediate and final phases of the Cybernetic Revolution as well as explain why medicine is to become the breakthrough sphere in the beginning of the final phase of the Cybernetic Revolution.

The third and the subsequent chapters of our research are devoted to the forecasts about the intermediate and final phases of the Cybernetic Revolution in the next 30–60 years, with respect to some fields the forecasts are given until the end of the twenty-first century. We study the development of those directions which in our opinion are most likely to trigger the future technological breakthrough, namely, medicine, additive (3D-printers), nano-, bio-, robotics, information, and cognitive technologies which we unite under the designation of MANBRIC-technologies. Altogether these areas will start the epoch of self-regulating systems which will provide unprecedented opportunities and also cause new unprecedented problems. One should note that the technological development heading for self-regulating systems correlates with the general evolutionary advance towards an increasing level of self-regulation within systems, especially animate and social ones. And it gives additional relevance to the subject of our monograph. The **third chapter** is devoted to the development of medicine. The **fourth and fifth chapters** consider the advances and future transformations of biotechnologies and nanotechnologies. The **six chapter** describes opportunities provided by others technologies, namely, robotics, additive and cognitive technologies, transportation, energetic *etc.*

The book also comprises **three Appendices** related to the first chapter. In the **first Appendix** some issues of the theory of historical process are considered (the notion itself as well as the procedure of periodization of historical process). In **Appendix 2** the authors present some tabular and graphic interpretations of the technological aspect of historical process (production principles and production revolutions analyzed by the authors) and some issues connected with accelerating historical process. **Appendix 3** establishes a close correlation between production principle cycles and Kon-

dratieff cycles, the latter being the repeated fluctuations of important economic variables with a characteristic period of about 40–60 years.

We hope that our research will be interesting for those who study the issues of technological development, its role in historical process and societal advance and also for those who would like to learn more about the future development of technologies and society.

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