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Does Covid-19 Accelerate the Cybernetic Revolution and Transition from E-Government to E-State?*

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Abstract

We elsewhere pointed out that the forthcoming sixth K-wave will merge with the final phase of the Cybernetic Revolution (the 2030s – the 2070s). Thus, the technological and economic tide will be more powerful than in the fifth K-wave. So any factors that may change the time or way of the Cybernetic Revolution will also affect the sixth K-wave. In this article we will analyze one of such factors. Among many influences that the pandemic has and will have on society and the World System as a whole, one of the most important is the acceleration of the start of a new technological wave and a new technological paradigm in the near future. This impact is determined by the growing need for the development of a number of areas in medicine, bio- and nanotechnology, artificial intelligence and others, which we denote as 'MANBRIC-convergence'. It is shown that the experience of dealing with the COVID-19 pandemic has confirmed that the final phase of the Cybernetic Revolution will begin in the 2030s at the intersection of a number of medical, bio-, digital and several other technologies, with medical needs as an integrating link. Among the multitude of

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self-regulating systems in the economy and life (which, in our opinion, will flourish during the Cybernetic Revolution) socio-technical self-regulating systems (SSSs) will play a special role. Thus, COVID-19 becomes a powerful impetus not only in terms of accelerating technological development and approaching the final phase of the Cybernetic Revolution, but also in changing sociopolitical (and socio-administrative) relations in the forthcoming decades.

Keywords: *COVID-19, Cybernetic revolution, final phase, self-regulating socio-technical systems, e-government, e-state, vaccines, biotechnology, AI.*

Introduction. Multidimensional Impact of COVID-19

We elsewhere pointed out that the forthcoming sixth K-wave will merge with the final phase of the Cybernetic Revolution (the 2030s – the 2070s). Thus, the technological and economic tide will be more powerful than in the fifth K-wave. So any factors that may change the time or way of the Cybernetic Revolution will also affect the sixth K-wave. In this article we will analyze one of such factors. Since we have already shown in detail the connection between the forthcoming sixth K-wave and the final phase of the Cybernetic revolution (see Grinin L. and Grinin A. 2014, 2016b; Grinin L., Grinin A., and Korotayev 2017a), the sixth K-wave will not be frequently mentioned here. There are a huge number of articles about COVID-19 pandemic (caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) and its effect on society (*e.g.,* Atkeson 2020; Baker *et al.* 2020; Grinin 2020; Irshad 2020; Jasiński and Bąkowska 2020; see also further references below). In addition to research on possible strategies for dealing with the pandemic (including its consequences) and various medical aspects, many other issues are being studied, from economic consequences to the impact on the climate (Aslam *et al.* 2020; Belhadi *et al.* 2020; Brammer *et al.* 2020; Chakraborty and Maity 2020; Forster *et al.* 2020; Yoo and Managi 2020). So far, with some exception (*e.g.,* Schwab and Malleret 2020), the study of this new phenomenon still seems mostly unsystematic. However, one may argue that the COVID-19 pandemic can become an important driver of even greater changes (*e.g.,* Brammer *et al.* 2020; Brem *et al.* 2020; Hofbauer and Komlosy 2020), whose nature and consequences, however, are still mostly unclear. We believe that it will significantly accelerate the processes that we have already discussed in our other works (Grinin L. and Grinin A. 2015, 2016a; Grinin L., Grinin A., and Korotayev 2017a, 2017b, 2020; Grinin and Korotayev 2015; Grinin, Korotayev, and Tausch 2016). It will also speed up some other processes that deserve close attention.

The COVID-19 pandemic has significantly changed the public's focus; these changes are likely to persist for a long time. Ultimately, this may lead to significant technological transformations, which, in our opinion, are rather underestimated.

In the present article we would like to show that the COVID-19 pandemic has become a powerful trigger which will both accelerate technological development in medicine and other areas – especially in the ones forming the MANBRIC-system[1] – and, at the same time, catalyze the convergence of these areas. This is greatly supported by the sharply increased demand for the development of a number of fields of medicine, bio- and nanotechnology, artificial intelligence and others. In a series of papers, including this one (Grinin L., Grinin A., and Korotayev 2017a, 2017b, 2020) we made some forecasts concerning a new technological wave forming the final phase of the Cybernetic Revolution, which is likely to start in the 2030s – the 2040s. In this article, we refine our forecast, arguing with greater confidence that due to the COVID-19 pandemic, the final phase of the Cybernetic Revolution will begin in the 2030s, that is, in the next 10–15 years.[2] The pandemic has not only confirmed our forecasts, but also allowed us to significantly refine and enrich them. What do we mean? First, the experience of coping with the COVID-19 pandemic has confirmed that the final phase of the Cybernetic Revolution will begin at the intersection of a number of medical, bio-, digital and several other technologies. Second, the fight against the pandemic has made significantly clearer the mechanisms which can provide such a breakthrough in medicine and related technologies. Our article is mainly devoted to the development of these ideas. In other words, we seek to show that among the many impacts that the pandemic of coronavirus has and will have on society and the World System as a whole, one of the most important will be the acceleration of the start of a new technological wave – the final phase of the Cybernetic Revolution (and the sixth K-wave).

We also argue that among numerous self-regulating systems in production, economy and everyday life that will thrive during the final phase of the Cybernetic Revolution, the socio-technical self-regulating systems (SSSs) will play a special role. With the help of AI they will regulate a variety of administrative and social relations. During the pandemic, there appeared an urgent need for regulation of public life, which served as an impetus for the development of such systems. Meanwhile, the employment of socio-technical self-regulating systems will almost inevitably lead to a noticeable change in social and even political relations in society, shifting them towards e-government and e-state. The present article also devotes considerable attention to the analysis of the latter, while addressing such an issue as the rapidly growing threat to privacy and personal data.

[1] MANBRIC is an acronym for a complex of technologies: Medical – Additive – Nano – Bio – Robotics – Information and Cognitive technologies.

[2] The initial phase lasted from the 1950s to 1990s; currently we are at the mid-modernization phase (for more details see below, especially Fig. 2).

Combining technological and social forecasts in a single study appears all the more important, since a systematic research of the relationships and interactions between the rapid development of various technologies, especially AI technologies, medicine and biotechnology, on the one hand, and social and political relations, on the other, unfortunately, remains insufficient. The COVID-19 pandemic has shown some mechanisms of such system connections, thus helping improve forecasts.

Research Questions

In this article, we would like to focus on the problems of a possible acceleration of the final phase of the Cybernetic Revolution in connection with the COVID-19 pandemic. The beginning of the Cybernetic Revolution marks changes in technologies and the coming of a new technological wave when medicine, bio- and nanotechnologies, AI and other technologies will play an important role. It also means an increasing influence of technology on social, political and other relations. In particular, the unfolding Cybernetic Revolution will be associated with the widespread introduction of self-regulating systems in production and a wide variety of services, as well as in everyday life. Self-regulating systems are systems that can function with minimal human involvement or without it (Grinin L. and Grinin A. 2015, 2016a; Grinin L., Grinin A., and Korotayev 2017a, 2017b, 2020; Grinin and Korotayev 2015; Grinin, Korotayev, and Tausch 2016). Among the existing and future self-regulating systems, we pay special attention to what we designate as *socio-technical self-regulating systems (SSSs)*. These are technologies designed to regulate administrative and social relations in society through combining the AI with other technologies; in some respects, they are able to perform functions of administrative/law enforcement bodies. The development of the SSSs will notably affect the change in social and even political relations, as well as it will lead to the transformation of the state into an e-state. *This paper focuses on the extent and way the coronavirus pandemic is affecting the acceleration and canalization of these technological, social, administrative and political changes. We consider these changes and trends in the short-run and long-run in terms of the theory of Cybernetic Revolution.* The analysis of the COVID-19 impact gives us some tools and opportunities to make long-term predictions with greater accuracy than in previous studies, and allows a better assessment of possible risks.

The focus of this article can be formulated in the following questions:

1) How can the coronavirus pandemic affect the speed and canalization of the approaching final phase of the Cybernetic Revolution, as well as the acceleration of the MANBRIC-convergence?

2) How does COVID-19 influence the formation of socio-technical self-regulating systems and how can their development affect people's social behavior and formation of an e-state in the future?

Despite the magnitude of these problems, they are closely interconnected, so we believe that they should be studied in a single set.

1. Theoretical Background

1.1. COVID-19, Breakthrough Technologies, and Ageing

In the present study, we use a number of studies on COVID-19, especially its impact on future changes in society (Schwab and Malleret 2020; see also above), as well as our own studies on the subject (Grinin 2020; Grinin and Korotayev 2020). Among many valuable papers on the topic, the article by Brem *et al.* (2020) is worthy of special mentioning since it provides an overview of technologies related to the treatment of the coronavirus, as well as adaptation in times of crisis. We also rely on a number of other works describing the use of different technologies during the pandemic (Abi Younes *et al.* 2020; Basu *et al.* 2020; Choong *et al.* 2020; Estrada and Arturo 2020; Jat and Singh 2020; Jung and Lim 2020; Musyuni *et al.* 2020; Shah *et al.* 2020; Skorup and Haaland 2020). Of course, we were also interested in works analyzing vaccination and other important medical and biotechnological issues, as well as their integration (*e.g.*, Brem *et al.* 2020; Chung *et al.* 2020; Javaid *et al.* 2020; Musyuni *et al.* 2020), in addition to general issues of technological forecasting and social change (Phillips 2007, 2011). In order to achieve our research objectives set above, we applied the theory of production principles, which has been elaborated for almost 30 years (see below).

In the analysis of global ageing, we rely on demographic projections, all of which predict an increase in this process in World System within this century, especially in high- and middle-income countries. In general, all population projections unanimously predict a rapid aging of the world's population in the coming decades (Alkema *et al.* 2011; Kaneda *et al.* 2016; Lutz *et al.* 2018; Raftery *et al.* 2012; UN Population Division 2019, 2022a, 2022b; Vollset *et al.* 2020; Wittgenstein Center 2020). In this regard, it is worth noting that the coronavirus pandemic has brought forward the problem of protecting the elderly as the most vulnerable part of population (see Brem *et al.* 2020; Fraser *et al.* 2020). In our works (Grinin, Grinin, and Korotayev 2017a, 2017b, 2020), as well as in the present article, we support the idea of the further progression of the global aging process (see Fig. 1 for an illustration).

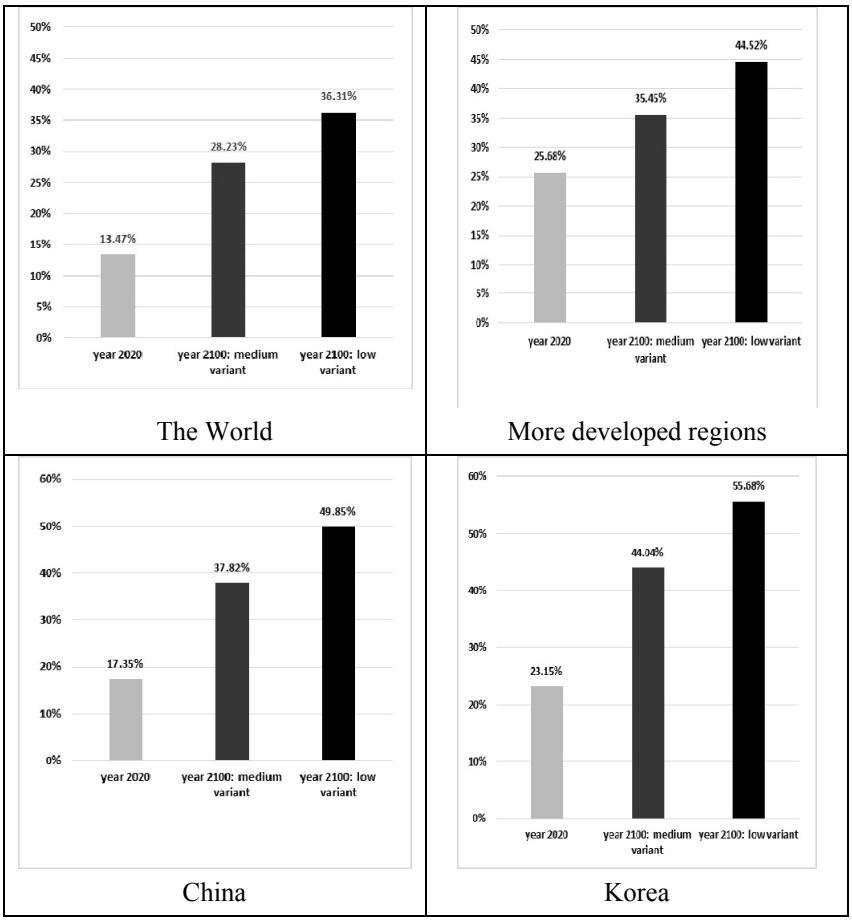

Fig. 1. Dynamics of the share of older people (60+) in the total population (%) in the 21st century according to the medium and low scenarios of the UN Population Division forecast

Source: The authors' calculation on the basis of the forecast estimates provided by the UN Population Division (2019). Low variant produces a lower trajectory of the global population as it assumes a more pronounced fertility decline, and, hence, corresponds to a higher share of older people (60+) in the total population. The lower variant appears more realistic due to considerations spelled out by Vollset *et al.* (2020).

The analysis of global ageing trend (*e.g.*, Goldstone 2015; Goldstone *et al.* 2015) has brought us to the idea of potentially increasing role of medicine and related technologies along with their development (see below).

1.2. Artificial Intelligence

For at least two decades, the scientific literature has been discussing the opportunities, prospects and problems of AI and its certain technologies, including machine learning, speech recognition, natural language generation, location tracking, *etc.* (*e.g.*, Abi Younes *et al.* 2020; Eden *et al.* 2012; Graglia and von Huelsen 2020; Gregg 2018; Hengstler *et al.* 2016; Liu J. *et al.* 2020; Mitchell *et al.* 2013; Montes and Goertzel 2019; Plebe and Perconti 2020; Russell *et al.* 2003).

We agree that AI may help find faster and better solutions to a number of problems. However, due to its rapid development, the artificial intelligence technology poses a major challenge for humankind (Eden *et al.* 2012). Therefore, it is important to study the possible threats from the development of AI and search for the ways to minimize it. Meanwhile, there are not enough studies on the current and future impact of AI on society in general and on changing socio-political relations.[3]

1.3. E-Government and the Problem of Privacy

In recent decades, there have been studied many aspects of e-government and its prospects (*e.g.,* Pérez-Morote *et al.* 2020; Silcock 2001), problems of its development, citizens' attitude toward it, as well as political and legal framework determining the level of e-government (Glyptis *et al.* 2020). Nevertheless, we believe that discussion about the future of e-government, which, in our opinion, may evolve into e-state, deserves particular attention. The discussions about e-government and application of AI and ICT are closely related to the impact that science and technology may have on privacy standards with account of the opportunities to access and collect personal information and use it against the interests of people. However, this is not a new issue. Alan Westin, in his book *Science, Privacy, and Freedom* (Westin 1966), analyzed the conflict between privacy and the use of the latest surveillance technologies. However, since that time, communication technologies, data analysis and surveillance technology have considerably advanced. As a result, the problem has become even more acute. A number of works have already been devoted to the analysis of its various aspects in the present and future (*e.g.*, Ashman *et al.* 2014; Cecere *et al.* 2015; Moustaka *et al.* 2019; Schwartz 1999; Solove 2008 see also Brammer *et al.* 2020, including information leakages [Alharbi 2020]).

[3] Except for the predictions of technological hyperoptimists (or 'machine superoptimizers' [Eden *et al.* 2012: 127]). They believe that the development of AI will soon result in a complete and radical change of the human biological nature and of the humanity as a whole (*e.g.*, Yampolskiy and Fox 2012; Kurzweil 2004, 2005). About technological pessimism see our article (Grinin, Grinin, and Korotayev 2017b).

1.4. The Cybernetic Revolution, MANBRIC-Convergence and Self-Regulating Systems

We also rely on the theory of production principles and production (technological) revolutions (Grinin L. and Grinin A. 2015, 2016a; Grinin, Grinin, and Korotayev 2017a, 2017b, 2020; Grinin and Korotayev 2015; Grinin, Korotayev, and Tausch 2016). We designate the technological revolution that began in the 1950s as *the Cybernetic Revolution*. We define three phases in the course of this revolution (see Fig. 2). The first phase lasted until the mid-1990s and was associated with the rapid development of fundamentally new technologies, including computer information technology. The second phase began in the 1990s and is still in progress. We suppose that it will end in the next 10–15 years. This phase is also very innovative, but still to a lesser extent than the previous one, and is more associated with improving technologies and their wide diffusion. The third phase, that is the final phase of the Cybernetic Revolution, which, as we have earlier forecasted, will begin in the 2030s or 2040s (below we specify our forecasts, defining the 2030s as the exact starting period of the final phase largely because of the COVID-19 pandemic; see also Fig. 3). It will be a new and powerful wave of innovation, which should accelerate the scientific and technological development (it is expected to continue till the 2070s). It will finally form the MANBRIC-complex of technologies. We define this complex by the initial letters of innovative technologies that are being actively implemented and will become the basis for the final phase of the Cybernetic Revolution (MANBRIC is medicine, additive, nano-, bio-, robotics, information and cognitive technologies). We are talking about the complex, because all these technologies are interconnected and the achievements in some of them support and develop others. Such development progresses to a noticeable extent in symbiosis. In our opinion, the centerpiece of the MANBRIC-complex and its integral part will be medical technology, which can unite around itself biotechnology (and, naturally, pharmacology), information and other technologies.

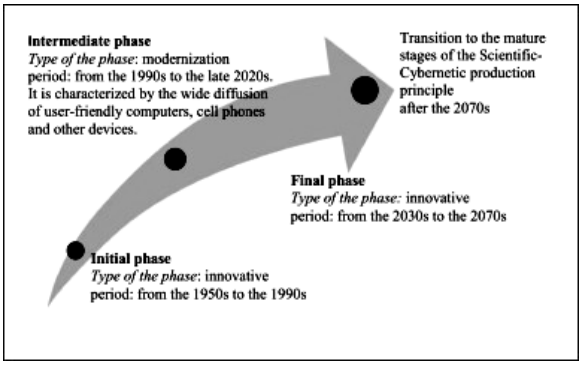

Fig. 2. Phases of the Cybernetic Revolution

We connect the integrative importance of medicine in MANBRIC-complex with a number of factors. Namely, with its growing significance for ageing society, increase in labor shortages, need of the working age extension, rehabilitation of disabled people; fast growing pension obligations (medicine can help here by extending the working age and improving the quality of biological life); growth of the middle class in developing countries[4] and, in general, with an increase in living standards and education in them, which in turn leads to an increase in the medical spending. Even before the pandemic medical research had a very prominent place in public funding of science in many countries, for example, in the United States (Research America 2017), Sweden (Statistics Sweden 2020), and others. But the COVID-19 pandemic has greatly increased the focus on health care. We will show below that the pandemic acts as a trigger increasing the importance of medical and related technologies (see also Fig. 3).

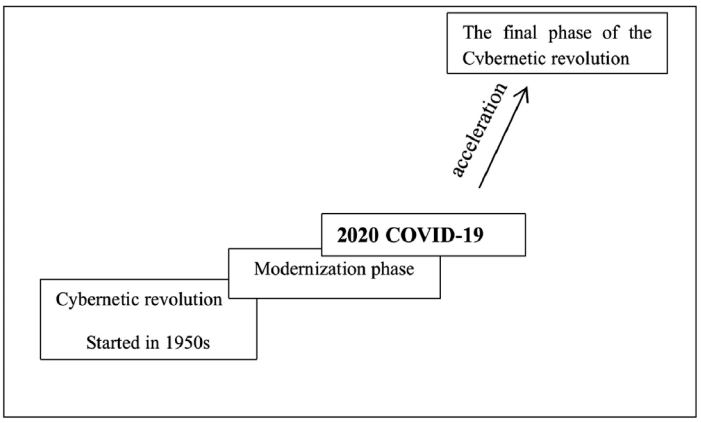

Fig. 3. Pandemic as a trigger of the final phase of the Cybernetic Revolution

In our previous works (Grinin L. and Grinin A. 2015, 2016a; Grinin, Grinin, and Korotayev 2017a, 2017b, 2020; Grinin, Korotayev, and Tausch 2016), we noted that the direction of general technological development in the final phase of the Cybernetic Revolution would go towards the development of self-regulating systems that would eventually become extremely widespread. *We define self-regulating systems as systems that can function with minimal human control or without it*. We also pointed out that socio-technical self-regulating systems (SSSs) will appear and spread along with other types of self-regulating systems (see above our definition of SSSs). We began work on the analysis

[4] However, in some developed countries, especially in the United States, this process has gone in the opposite direction.

of this phenomenon (Grinin *et al.* 2020), but the conclusions were only in the form of some theses. In particular we wrote that according to our theory of the Cybernetic Revolution,

> Numerous social self-regulating systems will begin to take shape. The proliferation of such social self-regulating systems will have serious consequences, possibly even fundamental ones. It will become possible to create certain systems of motivation and control over people's behavior in order to make it more predictable. Probably, this may appeal to the conservatism of the elderly generation (although there may be a backlash if older people follow the latest standards). But, one way or another, these consequences will be controversial (Grinin *et al.* 2020).

However, the COVID-19 pandemic has shown that this concept needs to be refined and elaborated. In particular, it is necessary to analyze how the development of the SSSs can affect social relations and transform the modern state into an electronic one.

2. Analysis and Results

The COVID-19 pandemic has become a phenomenon that for the first time in many decades or even centuries placed health care problems at the center of both intrasocial and global relations. The pandemic has affected almost every area of life and activities. This led to noticeable changes in technologies and their diffusion, as well as in economy, politics, and the life of society. It has also spawned a number of projects that can significantly accelerate the development of certain technologies, as well as change socio-political relations. In general, the analysis of data in different areas over the recent years allowed us to point out the following important changes in connection with the pandemic:

1) The socio-political and economic role of medicine has sharply increased due to the large number of COVID-19 cases. This significantly changed the government's attitude to health care services and its funding, including redistribution of the budget in favor of medical expenses (Abi Younes *et al.* 2020; Anderson *et al.* 2020), which led to an increase in its technological component (Abi Younes *et al.* 2020; Brem *et al.* 2020). In some cases, the redistribution of funds for R&D was carried out in favor of a number of medical and biotechnological industries at the expense of other scientific and technical areas (*e.g.*, Abi Younes *et al.* 2020; Basu *et al.* 2020) which is also in line with the latest WHO guidelines (see, *e.g.*, WHO 2020).[5] Thus, the needs created by the health care crisis have dramatically accelerated the adoption of a wide range of technolo-

[5] *E.g.,* reported expectations are that AI spending in health care and pharmaceuticals alone will grow from US$ 463 million in 2019 to more than US$ 2 billion over the next five years. Global R&D expenditures for the pharmaceutical industry will also increase (ABI Research 2020).

gies, and many companies have moved quickly in this direction (Schwab and Malleret 2020).

2) The role of red (bio-pharmaceutical) biotechnology as a decisive factor in returning society to normal life has grown. The development of vaccines gave impetus for innovative breakthroughs in red biotechnology and genetic engineering (*e.g.*, Abi Younes *et al.* 2020). Funding and application of these biotechnologies, especially vaccines, have dramatically increased (Chung *et al.* 2020; Zimmer *et al.* 2020; Corey *et al.* 2020; Jeyanathan *et al.* 2020).

One should note that with regard to COVID-19 vaccines, we also observe significant progress, as vaccines based on new principles have been developed and introduced, which undoubtedly contributes to the development of red biotechnology (Brem *et al.* 2020; Chung *et al.* 2020; Javaid *et al.* 2020; Musyuni *et al.* 2020; Abi Younes *et al.* 2020; Zimmer *et al.* 2020). But this also entailed a very high price for this progress. Unfortunately, this is a widespread phenomenon in development. We suppose that, one way or another, this largest experiment in history will sooner or later have an effect in the development of biotechnological science. But there is no doubt that its price could have been much lower.

The controversial role of the grandiose mRNA vaccine experiment is worth mentioning further. It is important to understand that one of the most serious obstacles hindering the development of the pharmaceutical industry from becoming more flexible is the overregulation of the new drug approvals. It takes many years, sometimes up to 15–20 years, before a new drug is approved. The reason is obvious: the need to protect patients' health from unapproved drugs. But this system makes the development of new drugs so expensive (and requires good ties in the government) that only very large companies can afford it. As a result, a number of more flexible small and medium-sized companies are deprived of the opportunity to operate on the market. Due to Covid-19, the procedures for vaccine inspection, testing, *etc.* were essentially removed. One cannot call this experience a success, because the vaccine effectiveness appeared to be far below expectations and the side effects very serious. However, this shows that it is necessary to look for options for the pharmaceutical industry to become more flexible, less monopolized, while maintaining the conditions for producing approved high-quality drugs. It is still unknown how to find the solution to this problem but eventually, even through trial and error, the solution will be found (perhaps, through the development of computer simulation, which will speed up the process). And it will lead to faster drug manufacturing and more effective drugs.

3) The need for isolation and social distancing has led to a dramatic rise in online technologies.[6] This led to an increase in the use of information technologies and their qualitative growth, including in the areas like remote / telemedicine health care services (*e.g.*, Basu *et al.* 2020; Shah *et al.* 2020), or remote psychological assistance (Liu *et al.* 2020), the use and development of biometrics, including noncontact one (Kumari and Seeja 2021). Let us also mention the distance education (Rapanta *et al.* 2020), which has already been actively developing (Ashman *et al.* 2014), but has now become a necessity (Dhawan 2020). One can agree with the forecast of the significant impact of the COVID-19 crisis on the speed, implementation and direction of ICT (Abi Younes *et al.* 2020). The Internet commerce has also demonstrated explosive growth which has increased the demand for innovations in robotics, including drones (Estrada and Arturo 2020; Jat and Singh 2020; Skorup and Haaland 2020).

4) The struggle against the coronavirus has raised questions of deficit of medical personnel and prompt treatment of non-pandemic patients in order to concentrate forces on dealing with the pandemic. Robots in medicine, in particular robotic surgery (*e.g.*, Kimmig *et al.* 2020) can appear useful in this case. The safety of doctors can also be achieved through the development of robotics (Kimmig *et al.* 2020; Palestino *et al.* 2020; Tang *et al.* 2021) and remote medical technology (Feil-Seifer *et al.* 2020).

5) The pandemic has given impetus to the development of a number of other technologies, in particular, additive technologies (Choong *et al.* 2020; Javaid *et al.* 2020), which also have important medical applications (Choong *et al.* 2020). Nanotechnology has also been stimulated, since the need for new materials (including for the protection of doctors) impacts their development. Nanotechnology is especially urgent for the search for new principles for the development of vaccines and drugs. Since modern biotechnology works with nanoscales, the development of effective nanocarriers is extremely important for overcoming the limitations of traditional antiviral therapy (Chauhan *et al.* 2020). In the future, cognitive technologies can also be widely used in medicine and other areas.[7]

Thus, the above-described phenomena have increased the interdependence between medicine, biotechnology, information technology, additive technologies (Choong *et al.* 2020), as well as nanotechnology (Chauhan *et al.* 2020; Palestino *et al.* 2020; Tang *et al.* 2021; Weiss *et al.* 2020).

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[6] Currently, according to some researches, about 37 % of jobs can be done remotely (Coibion *et al.* 2020; Dingel and Neiman 2020).

[7] *E.g.*, in Human-Robot Interaction (HRI), which is a growing area of research, and where the number of studies is constantly increasing (Feil-Seifer *et al.* 2020).

This also emphasizes the predominance of a number of areas of medicine, pharmaceuticals, biotechnology, medical devices, as a result of which they will be at the top of scientific and innovation programs (Abi Younes *et al.* 2020), which confirms our earlier conclusions about medicine and related technologies as a breakthrough point for a new technological wave (see above). *Thus, the measures against the COVID-19 accelerated the MANBRIC convergence, whose central and integrating link, as we noted above, is medicine. In addition, the analysis allows us to conclude that the role of medicine and biotechnology may significantly increase in the next decade. Therefore, we can argue that tackling the COVID-19 pandemic has acted as a powerful trigger accelerating the Cybernetic Revolution* (see also Fig. 3)*. This may result in the growing need for the development of a number of areas of medicine, bio- and nanotechnology, artificial intelligence and others, which we denote as MANBRIC-convergence. In a number of works we forecasted the wave, which we consider as the final phase of the Cybernetic Revolution. In this article, we refine our forecast, arguing with greater confidence that due to the COVID-19 pandemic, the final phase of the Cybernetic Revolution will begin in the 2030s, that is, in the next 10–15 years.*

Urgent solutions to health care problems are becoming a factor of global political and economic scale, without which the development of globalization will stall. Countries need to unite in the fight against the pandemics (Fisher and Wilder-Smith 2020). The measures taken in this direction actually bring closer the beginning of a new technological wave.

In addition, it is important to note that the transition to anti-crisis management of society and monitoring of the implementation of anti-epidemic regulations, including tracking of movements and contacts, has caused a surge in demand for artificial intelligence technologies, mainly for medical administrative purposes. This led to the introduction of techno-social innovations into society's life. We believe that these measures can accelerate the development of e-state technologies, change social relationships, as well as increase confrontation in society.

3. Discussion

As we have pointed above, the COVID-19 pandemic, by placing medical technology, organization of health care and medical control in society at the center of public attention has stimulated change and acceleration not only in technological innovation, but also in social, administrative and even political relations. All this represents in many respects a single complex of transformations that can be productively studied in a system (see Fig. 4).

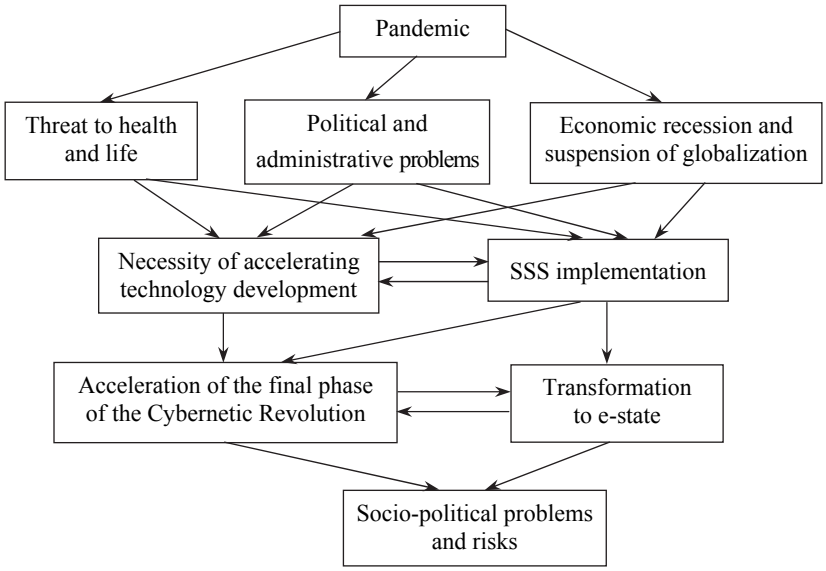

Fig. 4. Impact of the pandemic on the acceleration of the Cybernetic Revolution and the transformation of e-government into e-state

In this section we want to consider 1) the impact of the COVID-19 on the acceleration of the final phase of the Cybernetic Revolution; 2) the development of socio-technical self-regulating systems (SSSs), the way they can change social and administrative relations and support development of the e-state; and 3) some prospects and risks of these transformations, accelerated by the COVID-19.

3.1. How Can the Coronavirus Affect the Speed and Channeling of Advancement of the New Technological Wave?

Let us determine how the pandemic became the trigger. Why do we consider the pandemic as a phenomenon that will inevitably demand certain changes? The fact is that the COVID-19 pandemic has both undermined the idea of public safety and revealed the vulnerability of modern society to possible pandemics. Besides, it has not only posed additional threats to people's health and lives, especially to the elderly, but it began to depress the economy more than other economic crises and recessions (see Abi Younes *et al.* 2020; Grinin 2020; OECD 2020). In fact, the fight against the pandemic has set back the economy and social comforts, while at the same time pushed back, at least temporarily, globalization by suspending travel and tourism industry: flights, trade, *etc.* Moreover, it has revealed the need for changes at the world-system level. Sud-

denly it became clear that the pandemic threatened the development of globalization on many fronts, while breaking this deadlock requires additional development of various technologies.

It is likely that the abovementioned problems will not be radically solved in the coming years. In addition, the outbreak of another pandemic caused by new pathogens is highly probable, and it is necessary to be ready for it. In fact, there is a dilemma: come to terms with the destructive impact of the pandemic, expecting herd immunity, or develop various technological, social and sociotechnical innovations that will help to cope not only with the current pandemic but also with new ones. It is quite obvious that countries and the World-System as a whole will choose the second option. Accordingly, as we have seen above (in Section 2), such technological needs for innovations are relevant for those directions which form the MANBRIC-complex (*i.e.*, not only medical, but also bio-nano-robotic, AI, additive, cognitive technologies [Chauhan *et al.* 2020; Choong *et al.* 2020; Kimmig *et al.* 2020; Palestino *et al.* 2020; Tang *et al.* 2021; Weiss *et al.* 2020]). Both the pandemic and the need to overcome its negative impact, as well as the possibility of a new pandemic will powerfully stimulate a technological breakthrough and bring closer the beginning of the final phase of the Cybernetic Revolution. The competition between countries over vaccine development has intensified which in fact is a positive development and will contribute to the development of medicine and biotechnology in general. The urgency of safety issues and the emergency situation have helped to remove some of the obstacles to the development of science and technology, especially to the approval of drugs and vaccines nationwide and around the world. The approval system for new drugs and vaccines is changing dramatically due to the COVID-19 crisis and becomes significantly simplified and accelerated. In addition, the movement has begun toward the reorganization of some important areas of science (especially in pharmacology). In particular, according to Abi Younes *et al.* (2020), the pandemic has shown the need for coordination and openness at all stages of the research and product development process. We agree that scientific openness can accelerate the development breakthrough in science and technology.

Previously, we assumed that one of the main factors that would allow medicine, as an integrating part of the MANBRIC-convergence, to take center stage in both the technological wave and in solving social problems (including acute labor shortages, pension and social obligations pressure and others, see above) will be the inevitable accumulation of very large financial resources in the health and social welfare of pensioners. All these remain and will have their effect. However, because of the COVID-19 pandemic the problems of health care unexpectedly came to the center of public attention much earlier and appeared more acute (previously we had supposed that such a rise in the importance of medicine would only become evident only in the late 2020s). The

pandemic has intensified the role of medicine as an integrating part of MAN-BRIC-convergence.

3.2. Impact of COVID-19 on the Development of Socio-Technical Self-Regulating Systems and How This May Affect Social Behavior and Formation of the E-State

In recent decades, the development of information technologies and artificial intelligence has produced a noticeable impact on social relations. This impact can be seen in many areas, in particular, in the structure of employment, the withering of some professions and the emergence of others. Opportunities for distance education, jobs and services, including health care, are also rapidly expanding. In addition, much has changed in the field of creation, distribution, transformation and analysis of information and control over its flows. The development of technologies for tracking human activity leads to the commercialization (and actually alienation, according to the terminology of Karl Marx) of human behavior and privacy that were previously considered inalienable (desires, inclinations, habits, *etc.*). It has long been noticed that a new structure of power over people is emerging on the Internet. This state of affairs has serious implications for democracy (Schwartz 1999). Today's AI capabilities already entail systemic dangers to society and human rights (see Schwab and Malleret 2020).

As mentioned in the introduction, there is a growing problem of intrusion with the help of artificial intelligence technologies into people's personal lives, their privacy, and constant access to personal information (including intimate one). Moreover, personalization as an important characteristic of the Cybernetic Revolution is rapidly developing (Ashman *et al.* 2014; Grinin L. and Grinin A. 2015, 2016a), which exacerbates the problem of privacy breaches.[8] Therefore, it is extremely important to analyze the risks of this process. One should realize that information privacy is a value that helps shape the society in which we live and our individual identity (Schwartz 1999). The urgent need to monitor compliance with security measures during the pandemic exacerbated this problem and at the same time showed that further development in this direction will lead to qualitative changes. The fact is that new combined technological systems are being formed on the basis of AI technologies that collect, store and analyze information about billions of people, as well as networked ICTs. Such systems are aimed at administrative, legal, social and even political regulation and con-

[8] All this is amplified by the unauthorized use of data and the danger of its leakage with completely uncontrollable consequences. Leaks, of course, cause constantly scandals (see, *e.g.*, Alharbi *et al.* 2020). The fact that the threat to the confidentiality of personal information and privacy increases with the growth of technological opportunities leads to the perception of this problem by a large part of society as violations of constitutional and basic human rights (*e.g.*, Morley *et al.* 2020; Wen *et al.* 2020).

trol over the behavior of individuals, social groups and even society as a whole, up to the regulation of the World-System. SSSs will be used to regulate many legal aspects, sometimes hierarchical relations in society, and may cause the formation and widespread use of social ratings. In short, there is a tendency to delegate more and more tasks (Plebe and Perconti 2020) from the authorities to socio-technical systems. At present, such systems are actively implemented, for example in face recognition, location tracking systems, traffic control (*e.g.,* Transparency Market Research 2020), imposition of fines, electronic registration, issuance of documents and many others that were previously the prerogative of the authorities.

Let us recall that we call such systems socio-technical self-regulating systems (SSSs) and define them as systems that perform social and administrative functions (*i.e.*, control, verification, distribution, security, rating and other functions) using a set of technologies in the absence or little participation of officials and specialists. The development of SSSs is progressing rapidly. In some cases, they begin to be used in order to impose certain patterns of behavior on people. The most noticeable in this regard is China, where officials have developed the Social Credit System for individuals, businesses and government for their control and assessment for reliability, in particular, for example, for controlling non-urban residents (Kuznetsova and Mashkina 2020). Many projects of the Social Credit System have been implemented only as regional pilot programs, although there are plans to distribute them countrywide (Chin and Wong 2016; Creemers 2018), and which also serve as a model for other countries (Síthigh and Siems 2019). The years 2020–2021 were in some ways a turning point in this regard. For example, the use of facial recognition systems (including recognition of masked faces [Sulochanan Karthick Ramanathan *et al.* 2021]) has increased by around 7 % and may grow another 12 % by 2022 (Technavio 2020). Famous vpn company reported the presence of location tracking systems already in 42 messenger apps with at least 187 million downloads (Sean 2021) and it rapidly increases during pandemic (Stanley and Granick 2020).

The pandemic and the emerging need to control anti-epidemic measures have dramatically accelerated the development of such SSSs. In particular, electronic pass systems, control of movements, system of punishment, accounting systems, systems of businesses control and many other systems emerged as a result of the lockdowns and they can be considered as prototypes of SSSs and even drone monitoring (Lyon 2001; Morley *et al.* 2020; Ram and Gray 2020; Richards 2012; Wang *et al.* 2020) as well as electronic passports (COVID immunity passports) (Hasan *et al.* 2020; WHO 2020b; Leswing 2021), QR codes which are supposed to record all vaccinations (Barnes 2021), *etc.* Thus, the coronavirus pandemic has shown that the introduction of SSSs can become a fast developing process which will unfold within 10–20 years. In the future,

one may expect that the development of the socio-technical self-regulating systems will proceed in different directions while continuing to develop in the field of medicine. For example, there may emerge systems for continuous monitoring of health and critical parameters of not only patients in hospitals but also of people staying home (Grinin L. and Grinin A. 2015), including chronically ailing and elderly people.

The need to monitor compliance with COVID-19 restrictions led to the fact that such technologies began to be actively implemented by the authorities. However, their introduction not only improved the control, but has also brought up some problems, for example connected to the techno-social ranking of people (this issue [but with reference to commercial companies] has been discussed for a long time [see, *e.g.*, Lyon 2001]). Anyway, the positive aspects of SSSs are quite obvious, which is why they are spreading. SSSs in many different ways can significantly improve the social environment. Some evidence of this has emerged already during the COVID-19 pandemic. For example, in China several AI programs were used to treat mental health crises during the epidemic. For example, people at risk of suicide can be recognized using special artificial intelligence software by tracking and analyzing posts on Weibo and alerting certain volunteers to act accordingly (Liu *et al.* 2020).

However, such a rapid and uncontrolled implementation also carries serious risks. Obviously, there is a danger of increasing standardization of people and losing their individuality. One of the main problems is that over many decades people have become accustomed to freedom of behavior and this kind of regulations can cause and already are causing protests (Brennan 2020; Kowalewski 2020). As a result, SSSs can lead to the emergence of a considerable behavioral stratification in society, which will negatively affect its consolidation. This is especially true with respect to the elderly due to the fact that they are particularly susceptible to COVID-19 (Fraser *et al.* 2020). But let us point to a serious contradiction here. On the one hand, it seems logical that tighter restrictions are required for the elderly, on the other, given the fact that the older population is generally more conservative in their habits (Grinin, Grinin, and Korotayev 2020), all kinds of SSS implementations that reduce individualization, can be perceived by them especially painfully. Accordingly, the level of frustration of this population will be noticeably higher.

In general, it is not surprising that we observe a sharp increase in public and government anxiety and negative reaction on a part of a large sector of society (Brammer *et al.* 2020) and even massive protests against the COVID-19 restrictions. At the same time, we notice the division of society into groups caused by medical measures (Brennan 2020; Carothers and Press 2020; Kowalewski 2020; Gerstenfeld 2020), and cases of discrimination in relation to medical care, vaccines, *etc.*

So since 2020 there has been occurred a split society causing strong behavioral stratification, social tensions and turbulence. However, there may appear a

large number of outsiders, that is, a mass of people who fail to fit into the rather strict requirements of the SSSs and electronic state. Besides, deviant behavior will increase, such as rejection of such demands (*e.g.*, Kowalewski 2020).

The processes of active implementation of SSSs and other information and digital technologies, as described above combined with the COVID-19 restrictions, have intensified the role of the state, which, to a certain degree, is beginning to turn into an electronic/digital state (or e-state).

What is e-state? Traditionally (according to the United Nations e-government development database), e-government has been defined as the use of ICTs to improve the efficiency of government institutions and provide government services online (UNeGovDD 2013). However, the concept of *e-state* is something more advanced in this respect than e-government. We understand e-state as a *state with a significantly reduced number of state supervisory bodies, mainly based on SSS technology*. This can affect democratic procedures.

One of such major changes will be the transformation of public administration towards the increasing use of electronic automated forms of interaction and control. Speaking in the language of cybernetics, SSSs will create a new communicative circuit in the management of society, more precisely, it will change the contours of the relationship between the center and the periphery of society. In particular, it can increase opportunities for quick feedback from the public. The influence of the SSSs will be perceptible and will significantly change or even revolutionize the nature of governance. Major changes can be expected in the structure of the administrative apparatus. Some administrative units (*e.g.*, local governments, officials, special control bodies, *etc.*), which are important for the interaction between the central government and population, will disappear or will be transformed. As a result, the facilitated interaction between a citizen and a state will affect many officials and may deprive them of their jobs, that is, in many ways it will be a revolutionary transformation. On the one hand, this will significantly reduce the cost of the management process, thus the state will need much less funds for its maintenance. This is, of course, a positive process. But, on the other hand, the power of the state will increase, and management will become less flexible, since it will largely depend on technology and the human factor of programmers.[9] A historical analogy suggests itself. In the first half of the 19th century, workers had to adapt their physical, psychological and mental abilities to the needs of machine production. This led not only to the alienation of labor (according to Marx), but also to a large extent to the alienation of the personality of the worker (see Grinin L. and Grinin A. 2015). Like the described process, the technological features of social control in

[9] In addition, the social score system (in particular due the growing influence of medicine) can create some kind of ranks, or even castes, *e.g.*, medical ranks with unequal rights, which can be observed even today in relation to the elderly.

the future can force people to adapt to them, causing alienation and frustration. This will also be strengthened by the fact that electronically organized authorities will look like an impersonal, unusual and, therefore, alien government.

Conclusion

The COVID-19 pandemic has become a phenomenon that, for the first time in a long period, has drawn public attention to health service problems. This led to noticeable changes not only in technologies and their diffusion, but in almost all areas of life. The emerging acute problems and the need for their solution will affect the acceleration of certain technological innovations and the introduction of new forms of social regulations – socio-technical self-regulating systems (SSSs). *Thus, the COVID-19 pandemic has become a powerful trigger accelerating technological development in medicine and connected areas (what we call MANBRIC-convergence: medicine – additive – bio-nano-info technologies – robotics – cognitive technologies) and, at the same time, catalyzing the convergence of these directions and changes in socio-political (and socio-administrative) relations.*

The measures against the coronavirus pandemic together with applied new technologies and the SSSs will undoubtedly provide many tools to tackle new pandemics with unknown pathogens. If such negative events occur, one may expect that they will also increase the role of medicine as a technological and social factor, as well as channel the process in terms of increasing attention to technological development and, sooner or later, minimizing the associated risks. This has some practical implications. Our analysis of COVID-19 pandemic as a trigger for the acceleration of the Cybernetic Revolution confirms the ideas of the integrating role of the medical technologies in the MANBRIC-convergence and implies practical recommendations regarding the most promising directions of the technological development in the nearest future.

Since the above-mentioned points significantly increase the role of medicine and related technologies and can accelerate its progress on the way to becoming an integral part of technological development, within the framework of this study *we can argue that the COVID-19 pandemic has become the trigger for the acceleration of the start of the final phase of the Cybernetic Revolution*. However, the technological revolution is always associated with radical socio-political changes. In the present article, we discuss two major changes of this kind: the spread and development of the SSSs and the movement towards the e-state. Let us recall that SSS is a certain type of self-regulating systems, whose proliferation is the most important characteristic of the Cybernetic Revolution (Grinin L. and Grinin A. 2015, 2016; Grinin, Grinin, and Korotayev 2017a, 2017b, 2020; Grinin, Korotayev, and Tausch 2016). However, they do not regulate industrial relations and are not used in private life; rather they govern social, administrative or even political relations, and can be used by the authori-

ties of different levels and the state as a whole (as well as by the administration of service centers in which the authorities consider such regulation necessary: airports, crowded places, *etc.*). That is why the development of SSSs in one way or another pushes society towards the formation of e-state, that is, a state with a greatly reduced number of administrative bodies, mainly relying on technologies in the form of SSSs and AI.

Thus, since the measures against the pandemic have accelerated the development of SSSs and increased the demand for such technology, it has been shown that the COVID-19 pandemic is able to accelerate important innovations, not only related to medicine, biotechnology and some other technologies, but also connected with the development of social relations technologies and e-state.

Let us further explain why this may and should happen in the set of directions we have described and presented in Fig. 4. First, the fight against the pandemic and the necessity for testing and vaccinations concentrate enormous financial and other resources, comparable to what we observe in the area of caring for the elderly. And where large financial expenditure and interests are usually concentrated, there is a center of political and economic life. Secondly, the pandemic demanded immediate solutions that became urgent priorities of the states (*e.g.*, medicine supply or an increase in bed capacity in hospitals) and increased funding for the medical sphere. Thirdly, this means involving the whole society, not just part of it. And this was almost immediately accepted by politicians and placed on the agenda of their programs, which one way or another began to be implemented.

Consequently, societies and the World System received a strong impulse to move in the direction we have defined. However, such an accelerated progress of the technological wave and transformation of society can be quite painful, and inevitably causes and will continue to cause strong social and political tensions, protests and conflicts, while trust in governments may decline (Strandberg 2020; Vieten 2020). We witnessed this in 2020–2021 (Brennan 2020; Kowalewski 2020, whilst protests often take the form of violent clashes, occasionally intensifying (Carothers and Press 2020; ACLED 2020). We observe a return to the pre-pandemic logic of protest that underscores the depth of the crisis of power exposed by the COVID-19, during which inequality increased (Gerbaudo 2020). Therefore, it is important to study these kinds of social and political risks, which in some cases can lead a society to a deep crisis. Due to the negative impact of SSSs on violation of citizens' rights, at first, their expansion may cause additional growth of frustration, alienation and conflicts in society. We believe that due to the mutual adjustment of the SSSs and the mentality of society, the former will gradually improve, more and more adapting to the positions of different strata of society, until they reach the optimum. However, the process of adjustment of new socio-political institutions and technologies, as well as of the e-state, on the one hand, and the interests of various so-

cial strata, constitutional rights and freedoms, mentality, on the other, will be quite difficult (for the arguments in favor of increasing unrest see Reicher and Stott 2020). It is necessary to develop completely new laws that would optimize socio-technological interventions in people's lives, especially intrusion in their privacy. It takes a hard way through trial and error to move forward on the path to harmonizing technological process and social life.

It should be noted that the large-scale and prolonged lockdowns of 2020–2021 led to, as many predicted, very serious economic problems: decline in production, the collapse in technological, production and trade chains, shortages of a number of goods caused an energy crisis and rising inflation.

So, in 2020–2022 we witnessed a huge social confrontation related to the compulsion to vaccinate against COVID and the unwillingness of a large part of society to obey this compulsion and restrictions. This confirmed our assumptions that already 'in the nearest two decades before the beginning of the Cybernetic Revolution one can expect not only significant success in the field of biotechnologies, but also the intensity of social struggle and fierce competition between various forces' (Grinin L. and Grinin A. 2015: 254). We have already mentioned that this intensity of struggle is related to two major trends characteristic of the modernization phase of the Industrial revolution, that is, of the period before the beginning of the final phase of the Cybernetic Revolution: 1) the wide spread of new technologies with their simultaneous improvement; 2) the increasing public opposition to many changes. Therefore, on the one hand, in the next 15–20 years we will observe a widespread introduction of biotechnologies in our lives; on the other hand, this will undoubtedly intensify social, diplomatic and economic struggle against changes in traditions, national characteristics, real or perceived harm, *etc.*

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