Information development in NBICS-civilization of the XXI century

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Abstract. The paper examines the development trends of modern information technologies that will determine the paradigm of the civilization development in the 21st century. The essence of NBICS-technologies is considered in this paper, and their synergetic and convergent characteristics are revealed here. The socio-humanitarian component of the modern society development is analyzed. The influence of convergent technologies on the social structure of society is noted. A new role of the subject in civilized development is shown, and the main tasks are set for transforming the sector of education.

1. Introduction

In the history of humankind, various civilizations have evolved; their values and characteristics have changed. There is no established definition of the term civilization in scientific literature.

We can define civilization as the cultural self-identification of people, depending on a number of objective and subjective factors and realizing one or another development paradigm. There are various approaches to the periodization of social development in the form of civilizations.

For example, we can distinguish between traditional and human-made civilizations. At present, in essence, a new civilization is being formed - NBICS civilization. Many scientists, for example, academician Moiseev N.N., adhere to the point of view that in the emerging civilization it is extremely important to distinguish two components: scientific-technological component and moral-social component [1, 2].

The 21st century is increasingly called the century of global technologies, or NBICS (Nano, Bio, Inform, Cognitive and Social) technologies.

This is another paradigm for the development of human society, which determines the convergence and synergy of its subsystems, such as nanoeconomics, digital economics, bioeconomics, the information-oriented society, culture, art and education.

Therefore, in all spheres of society, the task is to find solutions and new strategies in response to the challenges of a developing technology civilization.
2. Theory

In the 21st century, integrated inter-industry technologies begin to dominate, and in the near future, supra-industry technologies will emerge from the situation. Scientific-technical and social convergence, thus, becomes the main innovation trend in the development of modern society. Nature-like technologies, including anthropomorphic ones that reproduce wildlife systems, are beginning to take the place of habitual scientific and technological progress. Practical life is also changing significantly under the influence of social technologies. Professor Orlova I.B., considering a new methodological message in the study of convergence of technologies and the problems of the human future, notes: “We are all inside a gigantic technological experiment on man, nature and society. We are its participants; we are both subjects, and simultaneously objects of the experiment. Its essence lies in the technologization of man and at the same time, the anthropologization of the technosphere” [3].

Replacing narrow specialization with transdisciplinary integration is a way to blur the boundaries between practical and cognitive activity. These processes open up the prospects of nature-like technologies for the transition from a technology civilization, which has already led to a systemic crisis in the development of humankind.

Convergent technologies, erasing interdisciplinary boundaries, are changing the paradigm of not only the development but also the cognition. The analytical approach gives way to its dominant role in the cognition of the synthetic approach. At the same time, scientific tools are changed, becoming more and universal.

These are nanotechnologies as a methodology of scientific knowledge and mathematics as a language of modern understanding of the world. Nanotechnology is the foundation of a fundamentally new organization of science and scientific technology. Its internal logic is aimed at combining highly specialized sciences into a single system of modern scientific knowledge. Some convergent technology researchers rightly point out the increasing role of the subject in the development of the world.

Therefore, Baksansky O.E. and Fursov V.V. write “... it became possible not only to simulate, but to reproduce wildlife systems and processes using NBIC technology adequately. Moving along the path of synthesis of “nature-like” systems and processes, sooner or later, mankind will approach the creation of anthropomorphic technical systems, highly organized “copies of the living” ”[4]. Thus, the transition to nanoscale, interdisciplinary and the convergence of the organic and inorganic worlds become the most important characteristics of the development of science.

NBICS technologies are changing the socio-humanitarian component of the worldview. “Previous technologies were created according to a person’s needs, to his requests and requirements, and existing technologies (for example, the same supra-industry ones – information-oriented and nanotechnologies) are able to change a person himself, which was not in the past. Moreover, more and more anthropologists note the direct influence of technology on the evolution of man as a biological species.” [5, 6].

The ever-closer interaction of various fields of science, the convergence of sciences and technologies is becoming the main trend in the scientific, technical, economic and social development of society. The narrow specialization of science and education is a thing of the past. In addition, there is a reduction in the distance between basic and applied sciences, as well as between the natural and social sciences. All this causes a synergetic effect [7, 8].

3. Experiment

The idea that a synergetic approach will become the fundamental principle of the formation of an innovative economy and technology civilization of the current century is increasingly being voiced. The drivers for this transition will be NBICS convergence processes. NBICS technologies will fundamentally change civilization in the 21st century and make it different from post-industrial one. It ought to be remarked the global development trends based on NBICS technology.

In the course of the research, characteristics were obtained for investment projects for mining in Russia (Fig. 1).
First of all, one should keep in mind the already converging tendency of convergence of nano-, bio- and information-communication technologies with cognitive sciences and technologies. In the future, these processes will determine the formation of an “innovative person” and an “innovative society”.

Another trend that is clearly manifested in countries that successfully implement national models of technology development is the implementation of institutional reforms aimed at modernizing and transforming the organizational and managerial architecture of national innovation systems [9].

The gradual emergence of social structures as a result of the development of NBICS-technologies began to form in the framework of the post-industrial society a “knowledge society” or “innovative society”, which includes “information-oriented society”, “nanoeconomics”, “bioeconomics”, “information” at different stages of its development economy ”;“ nano-community ”;“ cogno-economy,” cogno-community”, etc. Scientific knowledge becomes a factor of production and it participates in the creation of value added. The process of obtaining information and knowledge is gradually acquiring functions previously inherent only in capital. Centers of value creation are beginning to be scientific organizations. Social stratification will be determined at the level of knowledge carrier. The process of virtualization of institutions, economics and society is expanding. Naturally, many stereotypes of our consciousness will collapse. Moreover, this is another major development trend.

Finally, we emphasize that NBICS-technologies are gradually becoming global. This means that they both positively and negatively affect large regions of the world, the economy of individual countries, the population of the planet and countries of the world, as well as individuals. In the global synergy of NBICS-technologies, the leading place will be taken by cognitive sciences and technologies [10]. It is the cognosphere that will implement the convergence of almost all NBICS-technologies.

In the technology civilization, there is a new system of values and a rational approach to understanding the world around us is being formed, which no longer defines a person as standing above nature. During this period, the innovative development of mankind is explosive, but at the same time it occurs on the basis of humanization of the relationship between man, society and nature, which are in a complex non-linear relationship with each other [11]. Science is turning into a universal dimension of humanity. This is precisely the paradigm of the development of a new civilization.

In this context, we must once again pay special attention to man as the driving force of civilization development. In the 21st century, a “critical mass” of creative individuals will be required. An
innovative economy and an innovative society can not be created without innovative thinking. The role of cognitive science and technology has already been emphasized. At the same time, equally important tasks in this regard are confronting the field of education in response to the challenges of technology civilization.

The synergistic effect of the introduction of global technological innovations is determined by the efficiency coefficient of new basic technologies $p$ [6]. Expression (1) allows determining the efficiency coefficient of new basic technologies $p$

$$
\rho = 1 + \frac{q_{av}}{s(T_b) \cdot \xi(T_b)},
$$

где $q_{av}$ – the growth rate of the average technological level throughout the economy at the time of the rise of the time period;
$$
s(T_b) \quad \text{– accumulation rate;}
$$
$$
\xi(T_b) \quad \text{– return on capital over time.}
$$

![Figure 2. Predicted curves of the contribution of the synergistic effects of NBIC technologies to the US economy growth rates in the period 2018–2050 for the corresponding different values of the efficiency coefficient of new basic technologies $p$.](image)

In one of the published OECD (Organization for Economic Cooperation and Development) reports on digital transformations, it was emphasized that the desire and ability to know, the ability to think creatively and solve problems are necessary prerequisites for youth to adapt to the scale, speed and volume of digital transformations [12].

The education system in its current status still mainly forms the patterned thinking of students, that is, the ability to think according to a well-known algorithm. In the existing system, students present a demand for applied competencies, striving to apply and monetize them as quickly as possible.
Universities, for their part, continue to offer quantified education, structuring it by professions, competencies, standards, directions and profiles. This is an algorithmic training appropriate to the industrial era. At the same time, a transition to non-algorithmic systems is needed. The 21st century is changing the paradigm of education: from knowledge to thinking. New technologies in the post-industrial era require an interdisciplinary approach and integrative competencies. In the future, there will be no professions, according to many scientists, including futurologists. However, there will be problems that need to be solved on the basis of a set of actions within the framework of nature-like technologies, which in essence are effective and universal by definition. Therefore, in training, emphasis should be placed on students to acquire academic skills. Acquired knowledge does not have to be specialized. From a position of long-term development goals, it is required to train creativity and educate leaders.

NBICS-technologies due to the convergence of nano-, bio- and information-communication technologies with cognitive sciences and technologies in the future determine the formation of an “innovative person” and an “innovative society” and thereby fundamentally change the civilization of the 21st century. Scientific knowledge becomes a factor of production involved in the process of creating added value. In other words, obtaining information and knowledge is gradually acquiring functions that in industrial and post-industrial societies were inherent only in capital. Science is turning into a universal dimension of humanity. Many researchers emphasize that cognitive science and technology will take a special place. It is the cognosphere that will realize the convergence of almost all NBICS technologies [13, 14].

The new system of values in technology civilization poses challenges to the field of education of great importance. Digitalization, as a basic trend, is changing almost all prevailing models of education, including their content, the rector of Higher School of Economics Kuzminov Y. I. rightly notes. The report of the Organization for Economic Cooperation and Development (OECD) on digital transformations, published in 2017, highlighted the prerequisites for youth to adapt to the scale, speed and volume of digital transformations in the 21st century, namely: the desire and ability to know, the ability to think creatively and solve problems.

At the same time, integrative technologies require graduates of higher educational institutions to possess integrative competencies. At the same time, the domestic education system mainly forms in students the ability to think according to a well-known algorithm, offering quantified training structured by professions, competencies, standards, directions, profiles, etc. Such training is adequate to the industrial era.

The post-industrial era, as already noted, requires an interdisciplinary approach and integrative competencies.

Therefore, in education, a transition to non-algorithmic education systems is necessary, a transition from specialized knowledge to synthetic thinking.

Futurologists believe that in the future there will be no professions. Within the framework of hybrid technologies, which are inherently nature-like, which means effective and universal by definition, problems will need to be solved on the basis of a set of actions based on integrative competencies. Therefore, in training, emphasis should be placed on students to acquire academic skills. Acquired knowledge does not have to be specialized. From the perspective of long-term development goals, it is required to train creativity and educate leaders.

In general, this requires a combination of modernization and transformation of the education sector. This will require fundamental changes in educational programs and curricula. Great prospects are given to smart education, which requires a quick response to changes in the external environment, non-traditional formats of student and teacher communications, a new pedagogical design and seamless technology. In this context, the transition from a culture of loyalty to a culture of individual achievement is very important. Summarizing the above, it should be noted that the narrow specialization of science and education is a thing of the past. In response to new challenges, the education system will inevitably develop in a convergent paradigm adequate to the requirements of socio-economic development in the 21st century.
4. Conclusions
In conclusion, we note that the civilization of the 21st century, creating new innovative technologies, at the same time begins to face new global problems that require adjustments to the emerging paradigm of human development. The unpredictable synergistic effects of convergent technologies are possible and will cause new bifurcations, which once again determine the direction of human development.

The governments of developed countries, as key actors in the development of NBIC technologies, must today pursue a focused economic policy to implement the strategy of innovative technological breakthrough. It is necessary to concentrate all resources and efforts on the practical development of a cluster of NBIC technologies, which form a new structure of the global economy. The period from 2014 to 2020 is the most favorable time for the development and spread of a new wave of basic innovations based on NBIC convergent technologies.

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