

Social and Humanitarian Expert Assessment of Biomedical Innovations

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Abstract

Universal development convergence, which is an intertwinement, interaction and interpenetration of different social spheres, leads to new synergistic effects and rapid transformations of scientific, technological and social development of the society. Nowadays the necessity of introducing effective constituents of ethical and humanitarian comprehension of innovations to science, especially in the field of biomedicine, is becoming increasingly apparent. In this regard, it is of particular interest to compare the opinions of student-age youth and the experts – well-known Russian scientists on the use of new converging technologies and their impact on an individual and society.

Keywords: philosophy of science, interdisciplinarity, biomedical innovations, ethical and humanitarian expert assessment, human enhancement, converging technologies

1. Introduction

As early as at the beginning of the 20th century, the possibility of purposive impact on human mind and body was considered to be science fiction or utopian projects. The origination of genetic engineering changed the situation radically. Having deciphered DNA's structure, the rapidly developing science saw no real obstacles to bold genetic experiments. Complex manipulations with cells and their fragments, new gene series synthesizing, molecular cloning, transfer and integration of genes and their structural elements into another organism genome, artificial insemination of animals and people have become routine procedures. At present, methodological patterns and possibilities of biomedical technologies application have become clear. There are expert reports on the creation of organisms with a modified genome that has no analogues in nature: on gene therapy they write about treatment of hereditary diseases introducing normal genes into the cells-carriers of genetic hereditary diseases; on gene diagnostics they study detecting congenital defects, risks of certain hereditary diseases, genetically predetermined body response to specific medicinal drugs; on total genetic control they discuss identifying abnormal or undesirable genetic carriers; on genetic fingerprinting their studies concern person's identification based on his/her genetic characteristic features; finally, on cloning of the whole organism and/or its certain organs.

According to experts for modern genetic technologies, there are no fundamental theoretical limitations in engineering any conceivable combinations of hereditary features of new artificially bred organisms. This means that the issue of human future comes under consideration of applied sciences, ethics and politics rather than philosophical reasoning and fiction. Science, having at its disposal a set of advanced technologies, greatly increases human possibilities and inevitably causes significant changes in the society; moreover, universal development convergence, which is an intertwinement, interaction and interpenetration of different social spheres, leads to new synergistic effects, rapid transformations of scientific, technological and social development of the society, and serious psychological problems (Breazeal, C., Edsinger, A., Fitzpatrick, P., Scassellati, B., Varchavskaia, P. Social Constraints on Animate Vision (MIT Artificial Intelligence Lab.). <http://www.ai.mit.edu/projects/humanoid-robotics-group/cog/cog-publications/IEEE-vision.pdf>).

These trends are especially noticeable in the field of biomedical research, which can be regarded as a kind of 'training range' for developing and testing both new technologies impact on a person, his/her changes, and new mechanisms for his/her protection.

2. NBIC-Convergence: Concept Definition

The history of the development of the 20th century science changed its specialization from narrow to interdisciplinary, then to transdisciplinary, and now, actually, we deal with the synthesis of sciences. But the synthesis of sciences is a synergistic effect of their interpenetration and mutual enrichment rather than just a simple vectorial addition of methods and results. This synthesis is most clearly seen in the new scientific and technological patterns and is based on the so-called converging NBIC-technologies.

The term 'NBIC-convergence' was introduced in the report "Converging Technologies for Improving Human Performance" made for the U.S. National Science Foundation and Department of Commerce by Mihail Roco and William Bainbridge in 2002 (Roco, Bainbridge 2003). The report indicates the importance and peculiarity of NBIC-convergence, its significance in the development of the civilization, and the formation of modern culture.

Convergence comes from Latin '*convergo*' which means 'close in, incline together'. However, the modern meanings of the concepts of 'converging technologies' and 'technologies of convergence' are much broader and much deeper: they refer to the processes of interpenetration, interaction which create the basis for obtaining incredible technological results. Being put into practice, these results are so powerful that they are capable of interfering and altering the very nature of a person. Besides, it is their enormous resource that humanity is still unable to assess accurately due to the rapid development of NBIC-technologies.

Meanwhile, the impulses coming from the promising technological applications of scientific knowledge are becoming dominant in the development of science; 'technoscience' is being formed (Bruno Latour); a man as such is becoming the direct object of both scientific research and technological impact. Mihail Roco and William Bainbridge point at the evolutionary significance of these technologies for the nature of a man as a biological species. Now, the natural world is being filled with artificial creatures of biotechnology and nanotechnology, which carry a potential threat to the biosphere (Roco, 2003). "The distinction between artificial and biological is blurring. Our cognitive apparatus, which was formed during the evolution of the natural world, now is being transformed taking into account the evolution of natural-artificial world under the influence of technoscience" (Chernikova 2010). In this regard, not only scientists, but also the whole society, is worried about the problem of applying new and super-new technologies for changing the human nature.

3. Humanitarian and Social Consequences of Converging NBIC-Technologies

The result of NBIC-technologies converging should lead to the union of four global branches of today's science and technology: nanotechnology is a new approach to creating customized materials for specific purposes using atomic-molecular engineering; biotechnology will allow introducing biological constituents when engineering inorganic materials, thus obtaining hybrid materials; information technology will provide with advanced intellectual system of processing data, modeling and interface; cognitive technology based on studying the consciousness and the cognition will allow better understanding of mental processes and behavior of living beings, more effective developing of artificial intelligence and human-machine cyber-environment; social technology is vital for managing and harmonizing globalizing net world.

Converging technologies set up a new strategy for the civilization development; in this case they are in need of adequate social and humanitarian comprehension. Today, due to the development of converging technologies, which have an enormous transforming power, the question concerning the limits of such transformations with regard to an individual him/herself arises (Aseeva, 2013).

Even now, NBIC-technologies offer new opportunities for alleviating human sufferings, speed up the production of new energy sources, contribute to solving the problem of hunger, improve globally the whole health care system. There is a strong possibility of biological changing an individual by means of direct intervention into the genetic code and in the processes of human life activities (deciphering the genetic code, cellular technologies, simulation of biochemical processes, implantation of electronic devices and use of nanomedical robots). The idea of creating artificial life is becoming more and more evident (Bouchard, 2003).

At the same time technological possibilities, which are being revealed in the course of NBIC-convergence, will inevitably lead to serious cultural, philosophical and social upheavals. They refer particularly to reconsideration of such fundamental concepts as 'life', 'mind', 'person', and 'nature' (Kamensky, 2015).

The idea of creating HI-HUME technologies (by analogy with HI-TECH technologies) presupposed large-scale manipulation of human nature including cardinal improvement of health and enhancement of human abilities. Currently HI-HUME technologies are no longer separate modifications of technological patterns, which represent the implementation of several basic theoretical paradigms. They are now systemic and affect all the areas of human psychosomatic existence. F. Fukuyama (2004) distinguishes four areas where the transformation of human 'self' is already possible:

- neurophysiology and human evolutionary psychology;
- neuropharmacology and the technique of human emotions and behavior modification;
- gerontology and the development of the technologies of individual human life prolongation;
- genetic engineering.

However, the rapid development of converging technologies leads not only to new unprecedented opportunities, but also to new challenges and threats. The origination of NBIC-technologies has significantly changed the paradigm of scientific research. Today, the period between the creation of a theoretical model and obtaining practical results has become as short as it has not been ever. As a result, the emergence of new technological opportunities is often far ahead of the knowledge of fundamental basics that they contain, as well as the consequences of their application. That is why the introduction of new technologies must be preceded by the studies of their social impact, as well as the permissible limits of their application; these requires significant modeling studies of the alternatives of virtual worlds using supercomputing systems and deep insight into the socio-humanitarian nature.

It is necessary to pay attention to one aspect of new technologies application: it is the problem of new inequalities and new dangers of relations with 'others'. If a jump, as a result of which humanity will find itself in a new condition due to nano-technology and genetic engineering, will take place, where are the guarantees that it will happen to all the people at the same time? Therefore, both political cleavages and the system of social stratification, which will also be inevitable in posthuman society, will be constructed in a new way. Initially new technologies and 'paradisaical' opportunities will be available to the minority (Kovalev, 2011). How will the majority react? Will it be possible to cope with this new inequality?

Moreover, the process of human opportunities enhancement is at risk of becoming unmanageable, multi-directional and multi-functional. Thus, the original goal of the interface 'brain – computer' may be the corrective actions aimed, for example, at stopping loss of vision, but the technology created for this purposes can on its own, like mobile communication, get many additional features in the range of human possibilities. The paths of different ways of changing a person are blurry, intertwined and are involved in the convergence of different technologies, becoming more and more unpredictable. A famous Ukrainian geneticist Acad. V.A. Kordyum believes that the humanity has reached a final anthropogenesis stage which is characterized by the transformation of its biological form of evolution into socio-cultural form. This means that there is a time gap when the stability of the biosphere is already close to its minimum, but the noospheric (socio-cultural) mechanisms of self-regulation are still not able to provide a sufficient level of stability.

4. Convergent Technologies in the 'Mirror' of Youth Public Opinion

In 2014 an empirical study on two levels (at the level of students of higher educational establishments – 500 people and at the expert level – 10 well-known and reputable Russian scientists) was conducted. The goal of the research was to study the mechanisms of the formation of social assessment of modern convergent technologies, in particular NBIC complex system, as well as opinions, judgments and assessments of student-age youth concerning both the technologies themselves and the prospects and possible consequences of their development.

Students of economic, engineering, humanitarian, and medical specialties of Kursk universities (Russia) were student survey respondents. Scientists competent in the area under study and the allied sciences participated as the experts. Questions that the students and the experts answered partially overlapped, or were similar in accordance with the specific features of the both surveys.

In the course of the study, the respondents were asked the following question: "Do you know about NBIC-technologies?" As it turned out, 75% of the respondents know or have ever heard of NBIC-technologies (nano-, bio-, information and cognitive technologies). In particular, the young people are more or less familiar with information technology (33%) and nanotechnology (35%); 27% of the students surveyed heard about biotechnology; 5% of the respondent students heard about cognitive technologies. This data scattering can be explained by the fact that among the young people and in many information sources the information on cognitive

technologies is often not widely spread and is not considered as a separate technology in the public consciousness.

Among the sources from which the young people mostly get information about NBIC-technologies are the Internet (93.3% of the respondents), mass media, namely newspapers, radio, television (73.3%); a third of the students (33.3%) learned about NBIC-technologies from documentary films and programs, as well as science fiction movies. Also among the information sources, young people mentioned the specialized and non-specialized literature, and advertisements. Little information about the converged technologies comes from friends, family, populist literature and other sources.

Such distribution of information sources is due to the fact that today the Internet and mass media play an important role in the daily lives of people, particularly young people. Young people mostly spend a lot of time on the Internet and watching TV; so, both directly and indirectly they receive information about different spheres of life, including modern technologies. Currently, mass media is one of the main information-carrying media. Cinema contains many science fiction films on new nano-, bio-, information technologies. Robots are often the heroes of modern science fiction films, but the information and technological achievements taken as a basis of the plots in most cases carry a potential threat, however. There are a lot of documentaries, which subject is based on the new information opportunities and new achievements of nano- and biotechnologies, their development prospects and both real and potential consequences (Malinetskii, 2008). An interesting fact is that a quarter of the respondents learned about converged technologies from specialized literature; this indicates a conscious, deliberate interest for this subject.

Of course, if we talk about the information which young people would like to get on the technologies under consideration, it covers the subject of the level of development of the technologies in our country. Thus, 66.7% of the respondents would like to know more about the level of the development of nanotechnology, 53.3% – about biotechnology, 68.8% – about information technology, and 43.8% – about cognitive technologies.

Almost half of the respondents are concerned about availability of biotechnology; a third expressed a wish to learn more about the availability of nano- and information technologies. Availability of cognitive developments appeals to a quarter of the respondents. The young people (46.7%) are also worried about possible consequences caused by the application of the technologies under study, mostly it concerns biotechnology.

When discussing the topics related to the development of modern technologies in the classroom, the respondents' answers were distributed equally. 50% of the respondents discussed modern technologies, for example, while studying Philosophy, Chemistry, Physics, Information Technology.

The students were also asked a question concerning various events and activities (conferences, round tables, seminars, etc.) devoted to the development of modern technologies and their participation in such events. It was found out that only a quarter of the respondents (24%) know about such events and participated in them. This is shown in Figure 3. These thematic activities were devoted mainly to nano- and information technologies, as well as the general progressive technologies. Our experts were asked the same question. It turned out that the experts themselves, by their own admission, do not often participate in special activities and conferences devoted to the development of modern technologies, mainly because there are not so many of them. This fact again confirms the validity of the results of the students' survey.

Table 1. To what degree are you ready for the interference of technologies into human nature?

Possible responses	%
Disease treatment	31.3%
Technical appliances to make the lives (sufferings) of people with disabilities easier	43.6%
Informational technological devices implanted into the body	9.4%
Technological interventions that can improve intellectual, physical level of development of a person	9.4%
Creating bio-robots that perform certain types of work	6.3%
Complete integration of a human being and 'machine', technical inventions	0.0%
In total	100.0%

Considering the willingness of the students to allow the introduction of NBIC-technologies into our lives at a general level, the following data were obtained. The vast majority is ready for implementation of information

technologies (70%). This is due to the fact that nowadays these types of technologies have become ingrained in our everyday lives, and it seems logical that young people actively use the achievements of this area. Besides, the current time is not for nothing called the ‘age of information technologies’: the majority of people, especially young people, often cannot imagine their lives without various information devices. The implementation of the developments of nanotechnology is acceptable for 35% of the respondents. A small percentage of the respondents is ready for the interference of bio- and cognitive technologies into human lives (see Table 1).

The analysis of the distribution of the responses suggests that young people find it possible to use considered technologies only for humanitarian purposes. It is noteworthy that none of the respondents consider that it is possible to allow complete integration of a human being and ‘machine’ or technical inventions.

In this case, the vast majority of the young people are not ready to allow interference of NBIC-technologies in their body (72.2%). Perhaps this is due to the fact that 65% of the respondents find NBIC-technologies dangerous. Biotechnology triggers particular concern among the young people. Mainly young people are apprehensive about the fact that these technologies may get out of control, which, in turn, is fraught with serious consequences and threats. Some respondents are also worried that the development and implementation of NBIC-technologies could eventually lead to ‘smearing’ of the concepts of ‘a man’ and ‘humanity’, to blurring the boundaries between them, as well as to deepening inequality between people. The last is connected, firstly, with different levels of availability of these technologies, and secondly, with ‘the improvement of human nature’, when some people can become more developed (physically and mentally) than the others. There are some concerns about the commercialization of NBIC-technologies application. Ultimately, it can be said that some risks cause the others, and they are interrelated to some extent.

Young people’s opinions about the so-called ‘enhancement of human functionality’, ‘extension of a human being’, ‘improvement of human nature’ are distributed almost equally: 56% of the respondents consider it to be positive; the remaining respondents (44%) disapprove the possibility of such improvements.

Moreover, the vast majority of the respondents (90%) believe that the development of NBIC-technologies should be preceded by social and humanitarian comprehension, should be accompanied with social technologies which are mentioned more often today and should be subject to these technologies. This fact is confirmed both by the scientific and public communities. It should be noted that in recent years people have not been talking just about NBIC-technologies, but about NBICS complex system.

77.8% of the respondents believe that the socio-humanitarian initiative will allow anticipating changes caused by NBIC-technologies and managing them. In addition, according to the respondents, this will make it possible to control the application of convergent technologies (44.4%); this is quite logical because the majority of the respondents are worried about uncontrolled use of the technologies under consideration. In general, there is a trend of extremely restrained attitude concerning biotechnology.

Also among the positive features of socio-humanitarian initiative it is possible to distinguish versatile public education about these technologies, bringing them into the humanistic mainstream, providing NBIC innovative forms of social, legal, economic, and international coordination and cooperation (see Table 2). It is impossible to develop convergent technologies harmoniously and safely without this.

Table 2. What is social and humanitarian comprehension necessary for?

Possible responses	%
To anticipate and manage changes caused by NBIC-technologies	43.7%
To control the application of NBIC-technologies at all levels	25.0%
Social and humanitarian comprehension will allow educating versatile public community about NBIC-technologies	12.5%
NBIC-technologies development should have high humanitarian goals	9.4%
NBIC-initiative is in the need of innovative forms of social, legal, economic, and international coordination and cooperation; these can be provided only by means of social and humanitarian technologies	9.4%
In total	100.0%

It should be noted that, despite the various concerns that NBIC-technologies cause, the vast majority of the respondents believe that it is necessary to develop the technologies under consideration. As for the development of NBIC-technologies for everyday life use, the young people are mainly in favor of their application, particularly with regard to information technologies (90%), cognitive technologies (75%) and nanotechnologies (70%). Regarding biotechnology, the respondents' opinions are divided almost evenly: 55% of the respondents have a positive attitude to the biological developments application in everyday life; the remaining 45% are against such innovations.

Thus, today the young people are aware of the NBIC-technologies complex to some extent. This applies especially to the information constituent as the most common and the most available at the moment. However, despite the fact that the young people predominantly recognize the need for further development and application of convergent technologies achievements, there is a rather reserved attitude towards them, especially with regard to biotechnologies, which are considered to be extremely dangerous by many respondents. In general, the main concerns according to their opinions are connected with the fact that there is a possibility that these technologies can get out of control, be commercialized and deepen the already existing inequalities between people.

To a large extent such an attitude of young people to this technologies complex system can be explained by the information pattern created by the media and contemporary cinema. Modern films, in particular Western, American ones, very often have a storyline connected with the development, expansion, and application of super-technologies. Almost always alongside the tremendous possibilities that these technologies can bring to the improvement and the enhancement of human life, such films demonstrate huge threats of their thoughtless, uncontrolled application which menace to the safety of all mankind.

Based on the results of the conducted studies, we can conclude that the concerns of the young people about the uncontrolled NBIC-technologies use, deepening inequalities between different categories of people, as well as the existing level of the convergent technologies development and the need for their further development is determined by the influence of the media, the Internet, science fiction, etc. It is these sources and means that mainly form social NBIC-technologies assessment.

5. Experts' Opinions on the NBIC-Convergence Consequences

The experts, well-known Russian scientists who are specialists in the problem under study, mainly agree with young people, but there are some differences in their assessments.

According to the experts, the main sources in which NBIC-technologies are discussed in one way or another is the Internet, specialized literature and to a lesser extent documentaries and science fiction. In this aspect, there is a concurrence with students' opinions. However, according to the experts, when they themselves are searching for the information on the convergent technologies, they use mainly specialized literature and, to a lesser extent the Internet, documentaries, and TV-programs. This suggests that in open access there is not much qualitative information on the technologies under study and accurate information can be provided only by specialized literature. The experts mostly agree that there is not enough information in the open sources about the consequences of NBIC-technologies use for nature and the society, as well as about the nature of some constituents of NBIC-complex system. It is noteworthy what the experts say about the lack of information specifically with regard to cognitive technologies (Gorokhov, 2008).

As for the readiness of the experts to the introduction of the developments of NBIC-technologies in their lives, the results are rather contradictory. With regard to the application of information technologies, the experts support the youth and, in this case the principle of "post factum" works, i.e. when these technologies are already firmly established in our lives, we cannot image our activities without them. It is interesting that, unlike young people, the experts are more inclined to the introduction of cognitive technologies into our lives and to a much lesser extent, to the introduction of bio- and nanotechnologies.

Further, the experts were asked to make an assessment of new technologies at different levels. According to the experts, NBIC-convergence is assessed mainly positively among scientists; it is considered as a necessary and logical stage in the development of modern scientific interdisciplinary knowledge. The experts were unanimous when pointing out that only nanotechnologies got special attention at the state level. This is evidenced by the announcement of nanotechnology as a priority direction of the development, the creation of the State Corporation RUSNANO and a number of grant programs for research and application of nanotechnologies. The government considers modern technologies as the prospect of a new technological structure and the main innovative resource of the development of the country. While the public generally know little about NBIC-technologies, that part that has some idea about them, mainly considers them as something mysterious, fantastic, and ambiguous. According to one expert, such assessments are often formed as a reaction to the

activities of Russian scientists advocating the technologies that could overcome fundamental human limitations. Such assessments are often quite contradictory. Specialized and non-fiction programs on TV also have some influence, but mainly in the framework of 'fashion-oriented trends' which have often spontaneous, short-term and fragmented overview of these issues and cannot allow developing assessment mechanisms qualitatively.

6. Conclusion

The issue of human nature is a fundamental problem, and our future depends on its solution. HI-HUME technologies give us the possibility for self-constructing in accordance with pre-set goals. But the scenario of the future to which we aspire depends upon our moral choice, upon our sense of values, upon what is good and what is evil. And all these factors are changing with us. The future of human beings and the future of the world in which they live, is increasingly dependent on a human being himself, but it is still open and is still unpredictable. There is a growing need to include social technologies into NBIC-technologies complex system. Social technologies are aimed at performing the functions of the system of values and their regulation. In recent years, the letter "S" is more often added to NBIC-initiative i.e. NBICS – this means taking into account social technologies. They can become a controlling constituent in the NBIC structure, aimed at the moral development of super-technologies for the benefit of the mankind, the progressive development and avoiding all those negative and dangerous scenarios that we envisage and cinema creates.

Social and humanitarian knowledge and social technologies should become an integral part of this dynamic system and should serve as an essential factor in its development. In the near future, this factor should gain enough 'strength' to perform the functions of stimulating and forming the priority vectors of development, regulation, forecasting and expert authorization of the processes and results of convergent mega-technologies development (Boev, 2015). Social technologies are said to be a social institution of innovations and social creativity, diagnostics, tactics and strategy of social development. We believe they are capable of carrying out thoughtful humanitarian assessment of brilliant scientific discoveries.

Thus, the changes caused by the convergence of technologies can be characterized as revolutionary according to the comprehensiveness of the covered phenomena and the scale of future transformations. However, no one can say with any certainty to what consequences such changes will lead in the future. Will any favourable stable states be reached? Will the growth and complexification continue unlimitedly or will this path of development lead to some kind of catastrophe? But whatever surprising or even shocking the discussed possible consequences of NBICS-convergence would be, this process is already going on and the issue of scientific courage and honesty lies not in 'taking the back seat', but in its impartial profound analysis.

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References

- Aseeva, I. A. (2013). Social and Ethical Risks and Benefits of Human's Genetics Modifications. *World Applied Sciences Journal*, 25(9), 1349-1352. <http://dx.doi.org/10.5829/idosi.wasj.2013.25.09.13412>
- Boev, E., & Kamensky, E. (2015). An Innovation Civilization in the Context of the Anthroposphere Crisis of the Technogenic Society. *Asian Social Science*, 11(4), 328-335. <http://dx.doi.org/10.5539/ass.v11n4p328>
- Bouchard, R. (2003, June). *BioSistemics Synthesis. Science and Technology Foresight Pilot Project* (Vol. 4). STFPP Research Report. Ottawa.
- Breazeal, C., Edsinger, A., Fitzpatrick, P., Scassellati, B., & Varchavskaia, P. (n. d.). *Social Constraints on Animate Vision (MIT Artificial Intelligence Lab.)*. Retrieved from <http://www.ai.mit.edu/projects/humanoid-robotics-group/cog/cog-publications/IEEE-vision.pdf>
- Chernikova, D. V., & Chernikova, I. V. (2010). The problem of human nature in the light of NBIC – technologies. *Izvestiya of Tomsk polytechnic University*, 316(6).
- Fukuyama, Y. F. (2004). *Our Posthuman Future: Consequences of the Biotechnology Revolution* (pp. 3-7). Farrar, Straus and Giroux, 2002. Moscow.
- Gorokhov, V. G. (2008). Nanotechnology – new paradigm of scientific technological thought. *High education today*, 5, 37.

- Kamensky, E., & Shapovalova, I. (2015). Social risks of anthropogenic human-caused systems: relevance and prospects. *Advanced Materials Research*, 1073-1076, 2886-2889. Energy, Environment and Sustainable Development. <http://dx.doi.org/10.4028/www.scientific.net/AMR.1073-1076.2886>
- Kovalev, V. A. (2011). In expectation of new Frankenstein (about transhumanism, NBIC-technologies and posthuman world). *Russia and the world in the XXI century*, 9, 68.
- Malinetskii, G. G. (2008). Nanotechnologies: achievements and perspectives. *Science in Russia*, 1, 24.
- Roco, M. C., & Bainbridge, W. S. (Eds.) (2003). *Converging Technologies for Improving Human Performance*. NSF-DOC Report. Boston: Cluwer. <http://dx.doi.org/10.1007/978-94-017-0359-8>

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