Interdisciplinary Knowledge Problem in a High-Tech Society

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Abstract. The actuality and relevance of the problem is determined by the importance of transformations in the structure of science, represented by the growth of interdisciplinary researches, as well as a change in the strategy of cognitive activity, definitely stated in the synthesis of science and technologies. The answer to the question of how scientific knowledge is changing is important for choosing an adequate social development strategy, since the role of science and scientific technologies in modern society is dramatically growing. The purpose of the article is to set out the social and philosophical reflection of social and cultural consequences of mutual impact of the high technologies and the interdisciplinary researches in the information society context. The positive and negative sides of the mutual influence of the cognitive and innovative instruments of the natural, social, technical and human sciences, under the conditions of information and communication, nano- and bio-technologies development are manifested. Interdisciplinary researches are newly problematizing the concept of expertise, which should be an interdisciplinary synthesis and cannot be obtained within a certain discipline. The growing phenomenon of interdisciplinary science, which manifests itself in the fusion of technology and society, the emergence of human-machine hybrids, which causes serious anthropological and sociocultural problems, imply new challenges for professional epistemologists, dictate a public need for knowledge of the causes and consequences of the high technologies impact on people and society as a whole.

1 Introduction

Since the end of the XX century, planetary civilization has been faced with new challenges that threaten its very existence. Economists, ecologists, politicians, scientists, philosophers, writers, artists seek to answer these challenges using all possible means at their disposal. The global problems can be solved by the joint efforts of states, international non-governmental organizations, and all people of good will. Science, which has been at the forefront of human development all the time since its inception, plays an essential role in this matter. A feature of modern scientific researches is their interdisciplinary character. Interdisciplinary research tanks to V. Vernadsky' efforts at the very beginning of the last

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century contributed to the cognitive capacities unification in the various natural sciences. From the second half of the XX century a combination of natural, technical and social sciences and humanities began, which gave fruitful results in the study of complex ecological, technical and other systems. Particularly successful were such interdisciplinary fields as automation theory, cybernetics, systems theory, control theory, which were formed at the intersection of mathematics, symbolic logic, biology and other sciences. In particular, as K. Shannon noted, "the theory of automatons encompasses various problems, ranging from Gödel-type problems ... and ending with the problems of machine reproduction, adaptation and self-renewal" [1, p. 9]. But the fastest growing interdisciplinary studies have been conducted since the end of the last century due to the rapid development of high technology. As the authors noted in one of their works [2, p. 12], one of the important interdisciplinary fields in post-classical science was synergetics, which gave rise to a large arsenal of the newest means of cognition that most adequately describes the non-linear processes of reality studied by various fields scholars and scientists. This is just one of many interdisciplinary sciences that has revolutionized technological change, both in science and in various social practices. In general, interdisciplinary sciences that has revolutionized technological change, both in science and in various social practices. In general, interdisciplinary acts not as a deviation from a norm or a transitional state on the path to a new type of discipline, but as the way to gain a comprehensive and in-depth understanding of a process or phenomenon that acts as an object of knowledge "in an area which has no clearly defined borders, focused on important social problems that require the application of methods of various disciplines" [3, p. 33]. The result of the development of interdisciplinary sciences and their high technology is a real opportunity today with the help of a 3D printer to print not only human organs for the replacement of the ill ones, but houses and bridges (one of such bridges had already been published in the Netherlands), even food can be produced this way. Scientists predict that in 20 years, 3D technology will wipe out much of the world's trade. And what other consequences are possible as a result of the use of such technologies? After all, they will be able to print weapons and other means of killing people. Hence rises the need in philosophical study of the interdisciplinary sciences phenomenon in connection with the high technology development. This requires a comprehensive study both from the standpoint of epistemology and methodology, as well as the social implications of their results in different spheres of society.

2 Materials and Methods

The research of the problem has an interdisciplinary character itself, which requires an analysis from various fields of science that affect one or another important aspect of it. Theories of the post-industrial and information society are dedicated to the study of sociocultural changes taken place in developed industrial countries and provoked by emergence of new high-tech technologies (R. Aron, D. Bell, M. Castells, R. Darendorf, T. Forester, J. Galbraith, R. Katz, Y. Masuda, W. Rostow, T. Sakaya, E. Toffler, A. Turen and others). These studies have revealed the close relations between technology, science and society development at the present stage. Modern philosophical and scientific studies record that the foundation of science as well as its organization are changing throughout the XX-XXI centuries (V. Stepin). It is revealed that the technological approach extends to the whole spectrum of relations developed in the scientific activity process (R. Cohen, L. Mikeshina, E. Mirskii, N. Motroshilova and others). The works of B. Barnes, M. Cohen, A. Neklessa, V. Scheffer, B. Yudin and others state formation of a qualitatively new stage in the development of science and technology, as well as their interactions with society, which is shaped in the form of the so-called technoscience (technological science, corporate science, etc.)

The methodological basis of the study is systemic, activity-based, categorical analysis, philosophical explication and rationalization, historical-genetic and comparative-historical approaches and methods.

3 Results

Science as a system of knowledge in the course of its development constantly diversified cognitive means, relying on the advanced achievements of production and technology, which helped to expand the worldview boundaries in the diversity of its manifestations. At first, at the end of the XIX century the integration of the natural sciences and then the humanities was replaced by the need for their integration. Such processes were caused by the interpenetration of the cognitive tools of some sciences in the cognitive sphere of the others, borrowing above all the social and human sciences of the entire wealth of techniques, methods, technical means, methodological principles produced by the natural sciences, which at that time took long time to be developed. As we know from the history of science, such borrowings have not always been successful (an example of O. Kont and the followers of his methods of natural sciences in the study of social phenomena worth to be mentioned). They were unacceptable especially while studying the social nature of man, the features of his mental activity.

Further development of social and humanitarian scientific knowledge confirmed the need to develop a specific cognitive apparatus of the social sciences and humanities: along with classical cognitive practices – sensualist Lockian and "reflective" Marxist, Kantian unity of practical and theoretical reason, Poppian critical rationalism, as well as analytical philosophy – the most meaningful today, is hermeneutical and phenomenological cognitive practices [4]. In fact, the latter cover such phenomena that were inaccessible to classical cognitive means. These are temporality, intentionality, intersubjectivity phenomena, which are explored by the means of phenomenology; interpretation, understanding, clarification of meanings, life-world and others, the essence of which is revealed by the cognitive techniques of hermeneutics. It should be noted that since the second half of the XX century, phenomenology and hermeneutics have been used both in the humanities and in the natural sciences, since scientists began to take into account the socio-cultural context of the natural science development. Understanding of natural phenomena initiates the interpenetration of cognitive procedures, techniques, principles, and other means of the natural and human sciences.

Since the late XX and early XXI centuries, the development of scientific knowledge has demonstrated even deeper interactions between its various spheres and industries, contributing to the formation of substantially new sciences that have become interdisciplinary. In general, the science of the late XX - early XXI centuries is increasingly influenced by a technological approach to the development and functioning of knowledge based on the introduction of artificial intelligence and powerful computer technology. The latter intensify interdisciplinary connections in the sciences, because the objects of modern sciences are complex nonlinear stochastic self-organized phenomena of natural and social origin, and they require consideration of the large number of nonlinear interactions of various factors that affect one or the other. New technologies developed on the basis of interdisciplinary research have become not only an important factor in the transformation of the production of qualitatively new products, but also a means of cognitive activity, which facilitated the study by their help of such objects that were inaccessible to study in the periods of classical, and non-classical science. This is, first of all, information-communication, biological, nano- technologies. According to V. Onoprienko, "interdisciplinarity is often used as a synthesis of theoretical knowledge and technology,

knowledge and skills, both of which are built on specific cognitive strategies, that is, the epistemological context of interdisciplinary research is its integral component" [5, p. 23].

The essential role of high technologies in the process of gaining new knowledge is that they allow exploration of characteristics of abstract theoretical objects that were not available for direct study. The subject of cognitive activity is also changing significantly as we have faced with cooperative, coherent thinking of machine-human systems. In such systems, where the functions of intelligence are distributed between the formal-logical apparatus of machines and the heuristics of human consciousness, differently than they once were, the problem of objective and subjective is constituted [6, p. 70]. Such transformation of the subject and the object in interdisciplinary research is connected, among other things, with the feature of high technologies, which are based on the use of human-machine systems.

Scientists have warned against the absolutization of the role of computer modeling, especially in those fields of scientific activity based on the study of non-verbal thinking, manifestations of feelings, imagination, intuition, and other forms of "implicit personal knowledge" (M. Polanyi), etc. By the way, the possibilities of informational modeling differentiate, by the way, non-classical and post-classical science. If, during the heyday of non-classical science, cybernetics as an interdisciplinary branch was considered to be a perfect science, which is able to model by virtue an artificial intelligence, and moreover to force the machine to almost express feelings and emotions, then modern post-classical science will be more careful in evaluating the possibilities of cyber information. In particular, it argues against the ability of machines to simulate man's mental states, and therefore it is not possible to solve, in particular, a psychophysical problem with the help of exclusively computer technology, but the participation of philosophy becomes vital [7, p. 113].

The information and computer processes interaction permeates all spheres of public life in the information context, leads to an awareness of the growing role of high technology in the development of society, the latest means of communication based on the processes of information obtaining, transmission, production and storage. These phenomena set before the scientific community qualitatively new tasks related to the further development search for adequate methodological means and objectification of scientific research. One of the important tools, as mentioned above, is interdisciplinary technological science – computer science. Interdisciplinary technological science and computer science are one of the important tools to solve the already set tasks by specific means. The main task of computer science is to process and transmit information various with the help of computers and newest communicative means in the various socio-cultural practices. Information and communication technologies allow to represent in digital form different processes of natural and social phenomena models.

Another interdisciplinary science is synergetics. H. Haken has developed its concepts, principles and methods in the second half of the XX century. Synergetic concepts, principles and methods have become common for all scientific fields, because, according to its creator, systems which consist of diverse in nature components such as electrons, atoms, molecules, photons, cells, animals, or even humans, when they self-organize should obey the same principles. They form electrical vibrations, structures in liquids, chemical waves, laser beams, organs of humans and animals, animal populations or social groups [8, p. 16]. Most existing nature and society systems are non-equilibrium, probabilistic, open and unstable. Synergetic principles and methods "allow to cover a wide class of systems from the basic " hardware" sciences to the applied "mathematical provision" sciences [8, p. 17]. With any study, when qualitative characteristics are important, it is better not to overstate the quantitative role produced by a computer model.

Interaction of science and the latest technologies has a significant impact on the current possibilities of social processes research. There is a reverse influence on the scientific knowledge and modern technologies development through the society demands for certain scientific developments, its willingness to finance them, the availability of the necessary science technical, information and other means and devices. Thus, the socio-cultural function of technologies is dramatically enhanced in the scientific and technological activity of the information society. As a result, the researcher has to make a moral choice whether to study certain phenomena and to introduce the result of research work to the public.

The impact of the scientific and technological revolution directly contributes to the internal development of the interdisciplinary sciences and their cognitive tools. The theory of optimal control, decision theory, queuing theory, game theory, catastrophe theory, graph theory and others were developed under the influence of the technical sciences, which became the basis for the new interdisciplinary sciences emergence.

Particular attention and caution is required for scientific developments related to the scientist's interference with the human genetic code, human cloning (what is currently being discussed in the global community of scientists), high-energy research, further study of the microcosm, and the like. Many scientists believe that such studies should be banned on the grounds that sooner or later they will lead to catastrophic consequences in the military field or that technologies created on their basis will destroy human beings and the environment [9, p. 181-182]. This point of view is expressed by Ju. Habermas regarding the application of modern biotechnology. He formulates an extremely urgent warning about the social consequences of interfering with such technologies in the human body: "It is not a cultural-critical gesture of protest against the scientific knowledge progress that is acceptable, but only whether these scientific achievements affect our self-consciousness as responsibly acting beings" [10, p. 23]. It is obvious that the philosopher is concerned with the socio-cultural aspect of modern high technologies use. Similarly, the development of information and communication technologies and their introduction into the cognitive process might lead to scientific progress, a breakthrough in the world knowledge as well as it may contain a certain threat.

This becomes dangerous due to the business interest in earning profits from the high-tech innovative projects implementation, that might led to silencing of the negative Hi-Tech's application results and manipulating of the mass consciousness. There is an opportunity for information, technological management of consciousness – invisible suggestion of certain views by placing a person in a closed information environment. Active communication with real people seems uninteresting compared to passive watching the news or the TV series characters adventures. Those people and ideas are gaining in popularity and are catching the attention of the media. "The technogenic determination of various spheres of individual and social life is manifested in a wide range: from unconscious motives and attitudes of activity, stereotypes of behavior, mechanisms of perception and evaluation of external reality, values, attitudes generated by the prevailing technical rationality. All this set of states, processes, actions (individual and social) can be carried out both consciously (with critical reflection) and unconsciously (through means of attitudes perceived by people in the course of socialization - and in modern technogenic society these attitudes are determined by the prevailing technical rationality)" [11, p. 49]. Virtualization of people's daily life is increasing, that contributes to attitude towards Hi-Tech as a miracle, leads to increased dependence and helplessness of people before technology and reduces the responsibility for the consequences of its usage. There is a new type of contradiction that permeates human private lives: on the one hand, people are striving for the highest level of individual freedom in deciding their own destiny, and on the other, they are captivated by the swirl of Internet communication in which they are forced

to subordinate their views and desires according to the dominant in the Internet space. Important place in it belongs to the Internet publications, which connect people with information and its ratings. Few of the Network users are no caught into the skillfully placed web. Such consequences should be foreseen by researchers first and the public should be aware about the possible negative consequences of the high technology development.

This circumstance forces scientists to go beyond the horizon of their own science and look at the human world from the standpoint of all the wealth of knowledge accumulated by society. The French scientist E. Moren wrote about this very clearly in his work with the eloquent title "To the Abyss?". He was calling on scientists to join intellectual efforts in the name of our planet preserving: "Anthropological identity, as the planetary identity of the Earth man, in principle, is impossible without thinking, which is capable to combine disparate concepts and disciplines. The new knowledge that compels us to discover our planet Earth, as our common homeland Patria, as our common Motherland, as a system, the Gaia Earth, as the biosphere, and the place of the Earth in space, make no sense as they are separated from each other" [12, p. 37-38]. A scientist who survived the Second World War, fighting fascism in the French Resistance movement, looks anxiously into the future, rightly considering that now the process of development of science, technology, industry, economy is not governed by politics, ethics or thinking [12, p. 5]. He demands scientists to unite as they well understand that broken thinking destroys the integrity of the world, examines the problems fractionally, dividing what is in fact indivisible.

Most domestic and foreign researchers rightly believe that the latest technologies might objectively help to achieve a tremendous improvement in human abilities, societal outcomes, the nation's productivity, and the quality of life. As one could see from the figure given by R.E. Horn [13, p. 7] the integration and synergy of the four technologies (nano-bio-info-cogno) originate from the nanoscale offers the promise of changing the societal "fabric" towards a new structure to improve human lives. This picture symbolizes the confluence of technologies that now shows the realignment of traditional disciplinary boundaries that will be needed to realize this potential (fig.1). New and more direct pathways towards human goals are envisioned in working habits, in economic activity, and in the humanities.

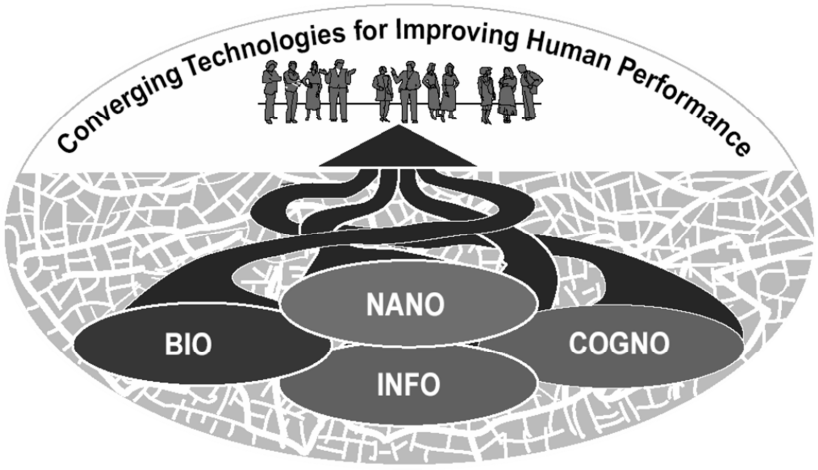

Fig. 1. Converging Technologies for improving Human Performance

At the same time, professionals require a mandatory control, which would allow them to achieve the desired effects in the future and eliminate, or at least mitigate, the negative phenomena that may arise from the practical usage of high technology [14, p. 84].

The new technologies emergence is in line with the objective demands of social progress that are associated with raising the social standards of human life. This also applies to the objective needs of the scientific community in the rapid acquisition of up-to-date scientific information. Such requests are also addressed by modern digital technologies that make possible international scientific on-line conferences, print scientific researches and get access to the general scientific community in different corners of the globe. A new global norm is the placement of scientific journals on the World Wide Web, which raises the requirements for scientific products, creates a struggle for rating among scientists and publishers of scientific publications.

S. Yagodzinskyi presumes that publications in the international Scopus database are crucial for modern scientific community. The researcher states that the private publishing house *Elsevier* aims to develop an information structure that would allow scientists around the world to obtain a fast and reliable tool to access the latest scientific developments and results, this is the main idea that lays in the basis of Scopus. The entry of a scientific journal into this database is considered to be a sign of the published production quality; such publications are a necessary condition for researcher status recognition [15, p. 37]. Information and communication technologies in promoting scientific products have a leading role as on international market and in free access for the general scientific community, as well as for students and graduate students.

An essential problem of interdisciplinary researches is their expert evaluation. If an interdisciplinary research plays the role of an intermediate and instrumental link in the cognitive process, scientists armed with disciplinary knowledge find themselves in a situation makes them to interact with their colleagues from other scientific areas. This situation, as a rule, is caused by external for science needs (social, political, economic), which require solving some applied problems. For this, scientists form a common theoretical and empirical research space in such way to enable them to help each other while doing their common business. But as soon as the desired applied result is achieved, scientists come back to the disciplinary fields, that is, they take with them the extracted grains of disciplinary knowledge that can be understood and accepted by their colleagues to enrich their own disciplinary knowledge. The interdisciplinary knowledge has a rather weak and uncertain epistemological status in the scheme mentioned above. At their best, interdisciplinary results can illustrate the practical effectiveness of disciplinary knowledge, but by themselves they are not planned to be included into settled disciplinary knowledge system with all the ensuing consequences. In fact, from this point of view interdisciplinary researches remain to be extraneous, time-serving formation in the body of the "real" science [16, p. 29].

Doubting disciplinary knowledge, an interdisciplinary research being successful may lead to the formation of a new special discipline exciting never before.

Schematic figure of current and future knowledge development represented in a summary of the report, Convergence of Knowledge, Technology, and Society; Beyond Convergence of Nano-Bio-Info-Cognitive Technologie [17, p. 23] shows that rapid advances in convergent technologies have the potential to give birth to new crucially important sciences. In this case, to judge whether the interdisciplinary knowledge is fruitful or not the expertise is needed. The expertise should be an interdisciplinary synthesis. This process is especially active in the framework of natural and technical sciences. Such a field as biology and partly genetics could be called leaders in this area, since the largest number of new interdisciplinary programs within the framework of enlarged groups of specialities is observed at the junction of these particular fields of knowledge with a very wide range of other sciences (fig.2).

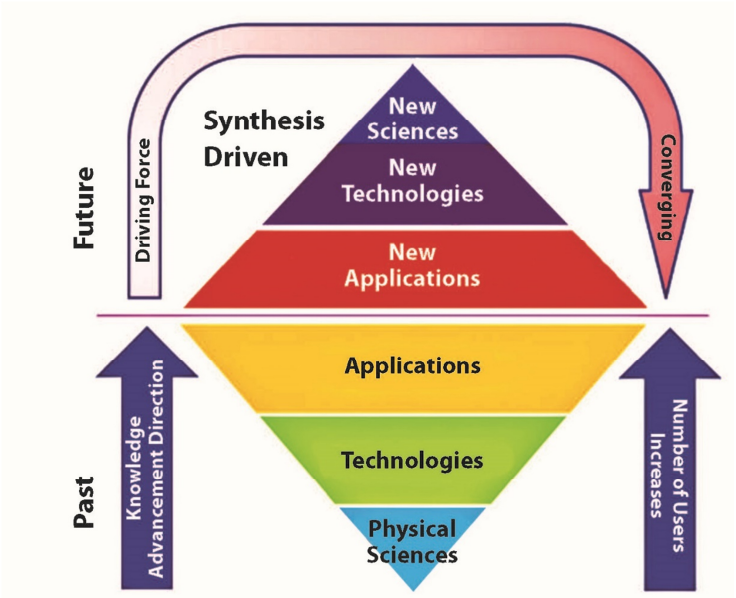

Fig.2. Synthesis driven.

If we turn to the Western experience of the leading universities in the USA, Great Britain, and Switzerland, we can cite many examples of interdisciplinary unification.

- Bionanotechnology unit is in the structure of the Biochemistry faculty, and besides an autonomous Computational Biology Research Group (CBRG) of Oxford university (Great Britain), providing researchers with access to a wide range of computational molecular biology programs;

- Medical Engineering (MedE) Faculty of California Institute of Technology (USA) brings together the best specialists from various disciplines in the field of engineering in critical areas of human health maintaining;

- Department of Chemistry and Applied Biosciences of Eidgenössische Technische Hochschule Zürich;

- Department of Information Technology and Electrical Engineering of Eidgenössische Technische Hochschule Zürich unites 17 research laboratories / institutes, having a dedicated bioengineering unit, engaged in imaging technologies and processing of neural information.

As an increasing number of universities begin to consider moving towards interdisciplinary higher educations, issues related to change management become critical [18, p. 25-27]. Successful and effective multidisciplinary research can lead to the formation of "softly connected" online research communities, working through electronic publications, forums and sites, and helping to reduce organization costs typical to institutionally rigid structures. For example, a seminar under the telling name "Rethinking Interdisciplinarity" [www.interdisciplines.org] has been operating in Paris since April 2003. Its core is the staff of the Institut Jean Nicod, Paris, whose motto is to serve interdisciplinary laboratory for the interaction of the humanities, social and cognitive sciences. Moderators of this seminar Ch. Heintz and G. Origgi emphasize that its goal is to develop special tools for the analysis and promotion of interdisciplinary researches, to study their definitions, details of organization, evaluation and prospects [19]. Networking events of this kind create a virtual place where researchers from different fields and disciplines can meet and discuss.

Since the changes taking place in modern science are radical in nature, the problem of cognitive activity, its methods, forms, and criteria cannot be solved beyond the philosophical knowledge and its field, epistemology. Modern philosophy in its non-classical status focuses on the analysis of various spheres and conditions of culture, identification of the fundamental vital meanings of cultural universals, implementation of an interdisciplinary synthesis of various knowledge, in order to present the philosophical-categorical matrix of human existence, which allows one to operate with philosophical categories in a condensed form.

It is necessary to develop such an area of philosophy as philosophy science as an interdisciplinary integrity that cannot be reduced to the elements of which it consists. The conceptual model of modern philosophy of science is qualitatively different from the positivist model, within which the philosophy of science is identical to the methodology and logic of scientific knowledge. Modern philosophy of science combines: logic and methodology of science, analytical philosophy, history of science, sociology of science (cognitive sociology), cognitive psychology, philosophy of technology, methodology of scientific creativity. In this concept of knowledge, methodological, sociological, axiological, anthropological discourses are complementary. The need to develop philosophy and methodology of science as an particular area of philosophical knowledge is important for the whole complex of sciences and for scientific activity as a whole. The development of the theoretical concept of "philosophy of science" as an interdisciplinary field in philosophical knowledge will forshorten the perspective on understanding the phenomenon of science as well as expose the problems of human dimension of scientific researches, maintaining the integrity of the scientific community, and mechanisms of its communication and training.

4 Discussion

An interdisciplinary scientific society consists of professionals of different disciplines included in the process of formation and application of new knowledge. The main problem is the content of the obtained new knowledge. The essence of the problem, its scale and complexity require many people to conduct mutual expertise to improve the effectiveness of working with many disciplines as well as within the new interdisciplinary field. What should be independent criteria for assessing and controlling the quality of an interdiscipline science existing in the global context of society? Who can conduct the expertise? Could it be a "multidisciplinary researcher" as a professional who is comfortable working across fields and collaborating with colleagues from a variety of specialties? Would presence of a multidisciplinary researcher who can replace two or more specialists in a multidisciplinary community lead to unnecessariness either to increase or to decrease the number of academic disciplines in a project team?

Nowadays a typical multidisciplinary community or project consists of specialists from various disciplines and professions who are involved in the process of joint work as interested parties directing energy to solving a common problem. Complex communications of such different entities as scientists, politicians, private investors, state or municipal officials and other actors engaged in technical innovation in society cause a contradiction between the need for autonomous standards of science and the involvement of science in society, being multicultural one in the realities of globalization. A multicultural society is not harmonious by definition. It quickly becomes controversial if it encounters different cultural groups, whose position is aggravated by social inequality [20, p. 2]. Does it necessary to ensure democratic access of citizens to science? In particular, S. Fuller emphasizes that public support, in most cases, is focused not on supporting fundamental developments but on near-time projects [21]. H. Nowotny, on the contrary, proves that

citizen participation can lead to fruitful research results regarding that the "cunning of uncertainty transforms promises into probabilities," and wondering who is claiming they have control over these probabilities and why [22, p. 167]. In any case, scientific and technological knowledge is becoming increasingly dependent on the opinions of ordinary people ("profane") who act both as consumers and as experts in assessing high technologies, therefore today, every argument, based on the principle of publicity, should be formulated in terms that are understandable to the public, not limited to only ascertaining, descriptive or futurological information, which contributes little to the solution of emerging social, environmental and other problems.

5 Conclusion

Interdisciplinary in science studies in its relationship with high technologies, developing at an accelerated pace since the end of the last century, has revealed the multidimensionality of this phenomenon. Its peculiarity is the unification of the scientists' efforts not only in related, but, at first glance, incommensurable sciences: natural and humanitarian; technical and humanitarian; natural, humanitarian and technical based on new mathematical theories. Another feature of interdisciplinary in science and in technologies lies in the socio-cultural intention of modern interdisciplinary researches, because it is about the mankind's survival in general (as many domestic and foreign researchers write about it), the need to prevent the negative consequences of interfering with human genome using bio-technologies, the moral-ethical responsibility of scientists for the results of high technology implementation, etc.

The goal of philosophical research in this context is a broad generalization of both the latest scientific theories and technologies to predict their future use, and the existing socio-cultural implications of the high technologies with an assessment of their positive and negative effects on humans, nature, society and the planet as a whole. It is important to analyze these influences from the standpoint of socio-philosophical, philosophical-anthropological, cultural and philosophical knowledge as well as other humanity disciplines in their dialectical unity for the joint identification of the basic laws of the information society and to warn society about the undesirable for social dynamics outcomes.

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