From Modeling to Technologization of Conscious Phenomena Based on Understanding

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Abstract: This paper briefly substantiates the necessity and possibility of transitioning from the empirical ways of cognition, relying on analogues, and the heuristics, using guesses (intuition) and associations (imitation), to the methods, approaching to natural-science, i.e., based on productive abstractions (paradigms), capable of regularizing the accumulated experience of spontaneous formalization of conscious phenomena, and forming logical paradigm for optimization of the existing practices and development of fundamentally new ones. The proposed solution is based on the convergence of natural science and humanitarian knowledge. Convergence is possible due to the fact that the results of both types of cognition include material bodies that are of a physical or quasi-physical nature. Sign constructions, that is, well-formalized quasi-physical bodies, such as computer programs and data, are convenient objects for research. The convergence of knowledge includes several levels: objects of cognition (spheres of phenomena), phylogenesis (model of Paradigm Innovative Development) and ontogenesis (Vertical Integration of Knowledge), methods of cognition (Parabola of Knowledge).

1. Introduction

One of the key problems of modern times is an unawareness of what is going on [1]. At the same time, they mean higher and large-scale social and economic forms of activities. Although, even these forms are based on certain ontological conditions. "Creativity comes with knowledge about the essence, as only the one, who knows the essence (has an ontology), is capable of creating. The thought, being the harbinger of creativity, needs to be supported in the ontological field, concerning which it can move, being confident that it moves meaningfully, i.e., essentially" [2]. At the same time, "Creation of "new" ontology is an individual substance, which is not connected with old essences: it requires giant internal efforts and is connected with transformation of consciousness and one's own essence (or concepts of "essences")" [2]. However, the favorable conditions for formation of the ontology of new reality are preceded by the activity, based on imitation of some samples or abstract principles, which are more or less connected with the practical problem, being typical for modeling.

Daedalus and Icarus, imitating birds, have managed to fly to the Sun, although their success was marred. The others were even less lucky. According to the legend, the medieval inventor explained to the local king that the failure was due to the fact that, while imitating birds, he used chicken feathers for his wings, and chickens are bad at flying. The king argued that people would be able to fly, but differently than birds. That is what happened when the ontology of machines and the environment they operated in became understandable.

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Cognition can begin with imitation, but it is not necessary to stop there. It can be productive before a certain height of the object variety threshold, following which the application of modelling becomes problematic. In the sphere of information phenomena, the existence of complexity barrier, caused by semantic variety and variability of data, is evident. Earlier it was called the curse of complexity [3], but further an engagement with small fragments of the unified field (of network) of data became an unwritten standard. The barrier remains, but people are accustomed to it.

The reason should be found not in the lack of inventiveness, but in the lack of understanding of the object ontology. In particular, until now, people are unable to realize what the program or data is [4]. The artificial intelligence is not able to address this problem. It, like an advanced manufacturing, needs not just huge, but also semantically varied and flexible structures of data. The complete implementation of IT potential is impossible without it. In particular, overcoming of the fragmentation of programs and data requires their unification and possibility of flexible response to changes. For this purpose, multiple bases of data and programs, consisting of unique products, should be represented by the limited sets of invariant forms and structures.

At present, the programs and data are mostly seen as conscious phenomena. Therefore, technologization of their creation and application to information practices, ideally requiring objectivity and completeness of knowledge, is difficult. It is necessary to converge natural-science ontological knowledge, capable of generating machines and technologies, and knowledge of conscious activity. Today, in the course of application, such knowledge can be interpreted in different ways. Conditions must be created for formalized integration of non-fragmented networks of programs and data with physical and organizational mechanisms to handle them. Such condition is an identification of the objectively existing commonality (mutual assimilation, convergence) between machines, on one hand, and programs and data as well as other types of signs, on the other hand.

It is not a problem of only information technologies. It is a mutual problem of the signifiers and the signified, i.e., signs, wherever they are used. The paradox of productivity of information technologies in economy and business [5-6] has not yet received any convincing explanation. It is a result of the paradox of practical productivity of semiotics [7]. Finally, considering the expression “world as text”, where the text is signs, as something larger than an unexpected metaphor, it is impossible to disagree with Luciano Floridi that it is about the global problem of the 21st century [8].

2. Convergence. What Is It and What for?

2.1. What is the Information Technologies?

At the current stage of development, this term means an application of data processing technologies (TODP) which are purely physical, being the product of natural science (physics, chemistry) and informational practices, being the conscious activities like economic, social, cognitive, managerial etc. Understanding of the latter is at much lower pre-scientific level.

This duality of IT and its mismatch causes the problems, among which is “Disintegration of TODP and Informational Practices” and “Excess of information with simultaneous deficit of relevant information”. This inspired to start thinking about the problem of mutual integration of TODP and informational practices through their convergence.

2.2. Convergence and Divergence

There is an integration through the convergence of the sphere of machines and the sphere of conscious phenomena (knowledge). The convergence is the process, in the result of which different phenomena obtain more properties that are common. In the result of divergence, on the contrary, their quantity shrinks. The existing machines are physical objects with physical properties: mechanical, hydraulic, electrical, optical etc. that is why the convergence of machine and knowledge is considered in case of humanitarian knowledge. Experience of the direct integration of machines as artefacts, which are the effects of conscious phenomena with ontological knowledge

about humanitarian, conscious phenomena, which have machine features as quasi-physical effects is shown in this paper.

2.3. Noosphere

Computer is a physical device, information is conscious phenomena. According to Cartesian dualism, they are phenomena of different orders. The alternative ideas are represented in the philosophy of V. Vernadsky, P. Teyar de Shardin, and E. Leroi who suggested the term "noosphere". V. Vernadsky stated that social history was a direct continuation of naturally historical development [9]. The noosphere is a sphere of conscious phenomena which includes the sphere of life phenomena - biosphere, but noosphere cannot be reduced to the latter. Biosphere contains geosphere, but cannot be reduced to it. If conscious cannot be reduced to the alive, and the alive - to physical, it should be understood, what, except for physical substance, connects them at the level of essences, produced by phenomena.

Consciousness reveals itself in an activity and its material results (effects). They have physical or quasi-physical nature and differ in the way that their parts are connected. In physical objects, they are connected with physical links. Another thing is a quasi-physical object like a program. Its parts - text of the program and the process it signifies - are connected through the relation of correspondence. The term "quasi-physical effect of non-physical (conscious) phenomena" can be found in the papers of Merab Mamardashvili [10]. He attributes this discovery to K. Marx. Understanding of quasi-physical object is obtained inductively, as an abstraction, which simplifies the results of experience in development of programs and databases for business purposes.

2.4. Second Section the Aspects of Quasi-Physical Convergence of Machines and Knowledge

The primary focus is on sign constructions, more specifically, on computer programs and databases for economic and organizational purposes. The view on the convergence of machines and humanitarian knowledge (particularly, economic and organizational ones) demonstrates:

1) convergence of spheres and objects of cognition;
2) convergence through the ontogeny of knowledge (the Vertical Integration of Knowledge - VIK);
3) convergence through the phylogeny of knowledge (Paradigmatic Innovative Development - PID);
4) convergence through the methods of cognition (Parabola of Knowledge - PK);
5) convergence through quasi-physical ontology of signs.

3. Convergence of Spheres and Objects of Cognition

The world as an object of science is traditionally represented as consisting of two parts. The first part is within the competence of natural sciences, the other one - the humanities. At the end of 19th century, as a result of convergence-divergence processes, they have seen the geosphere (physiosphere) and biosphere in the first part. The result of cognition turned to be dependent on the way, leading to it.

V.I. Vernadsky called the next milestone, which he has found in that direction, noosphere. Obviously, he was referring to the field, which is directly related to consciousness, i.e. the humanities. He claimed that social history was a direct continuation of natural history, although, he did not mention the objects that noosphere consists of. With the emergence of computers, it became clear that it is information (infosphere) or signs (semiosphere), ontology of which, like the ontology of noosphere, is also still undiscovered. The controversy is settled, if accept that all such spheres in the beginning of cognition are the set of phenomena. Their essence, i.e., objects, is revealed in the course of cognition.

Therefore, physiosphere is a set of physical phenomena, biosphere - biological phenomena, and noosphere - conscious phenomena. At the same time, biological phenomena are not reduced to physical ones, and conscious phenomena - to biological ones. The conditional nature of the term "conscious phenomena" is realized. Actually, there are no unconscious phenomena, as the

phenomenon is something that occurs to consciousness. The definition “conscious” is a reminder of the relationship between the activity and consciousness.

Having linked the spheres of natural and conscious phenomena into a chain, V.I. Vernadsky made extremely important and crucial step towards convergence of natural and humanitarian science, technologies and activity. For many philosophers, particularly dialecticians, their commonality is obvious. For example, A.F. Losev formulated the same statement with the utmost accuracy and completeness. In particular, in his papers “The Dialectics of Myth [11] and “The Philosophy of the Name” [12]. However, the assertions of V. Vernadsky, being a great physicist and biologist, science institutor and practitioner, without resorting to philosophical language, draw attention of serious scientists as well as sensation seekers to this problem for a century.

V. Vernadsky demonstrated the integrity and therefore the possibility and necessity of convergence of sciences, but he did not clarify how to implement it, how to link the driving forces of consciousness, gushing out from the depth, with superficial facts of the ongoing life. The answer can be found in the problem statement, if to look towards not only to the future, i.e., conscious phenomena, but also to the past, i.e., experience in development of natural sciences.

There is a need for ontology in technologies. The fundamental sciences - physics and biology, are the sciences of ontology of their objects, but no one succeeded to build the ontology of consciousness. Most probably, it will never be achieved. How, then, can one technologize the sphere of conscious phenomena?

Let’s look at this problem from different perspective. In respect of natural phenomena, technologization turned out well, though physical phenomena are also dependent on consciousness, which perceives them. The point is that it is not the phenomena themselves, but physical, chemical and biological effects of cognition and other activity, which act as the objects in natural sciences. In this sense, all these effects are artefacts to the greater or lesser extent. It turns out that even in case of natural phenomena people study not them, as they are modified by the consciousness, but their effects. It should be noted that no one attached much importance to this before Galileo Galilei, apart from Ioan Gramatic, and, for example, Aristotle considered the sphere of conscious phenomena as conscious sphere, believing that its intrinsic feature is purposefulness. After Galileo Galilei, this was forgotten for over 300 years as they deemed it unnecessary. Today, it is time to recall it and fix as a pattern of cognition.

Why, in case of conscious phenomena, doesn’t one leave the attempts to comprehend the whole their depth, completeness, variety, variability, subjectivism, etc. to philosophy, humanities, literature and art? As for technologization purposes, there is a need to focus on cognition of material side, i.e., effects of such phenomena. These are programs and data, i.e., quasi-physical effects, which can be only artefacts and cannot be fully reduced to the effects of natural origin. This will also be a necessary step in the transition from modeling, as the primary tool in the empiric-heuristic cognition development phase, towards suggesting and verifying scientific paradigms.

4. Convergence of Phylogenies of Knowledge

Therefore, what all phenomena have in common is that they are more or less dependent on cognition. At the same time, natural phenomena produce physical or biological effects, which are minimum dependent on cognition. In return, they are more dependent on substance. The artefacts (artificial bodies) have higher degree of dependence on cognition, than the natural formations. The so-called conscious phenomena produce quasi-physical effects, which are artefacts.

The divergence between natural sciences and humanities is relative. It also should talk about natural sciences from the humanitarian perspectives. The reverse is also true. The natural and conscious phenomena can converge within the framework of their effects. They can be physical and quasi-physical, the difference between them is in the way of connecting the parts.

All the above-said create conditions for unification of knowledge genesis across all spheres of phenomena, i.e., phylogeny. Figure 1 shows the phylogeny of physiosphere. At the same time, the key moment is the emergence of computer, which took place in the scientific phase of the development of physiosphere. The computer was not a sudden discovery. It was created on physico-

mathematical logical basis. The attempts to create logical machines and universal languages were also taken in the beginning of the last century [13].

As can be seen from Figure 1, the sphere of information phenomena, where the computers are used, in the period of their emergence, was in the phase of pre-paradigm empiric-heuristic development and continues to stay there even now. This phase is characterized by empiric, relying on analogues, heuristic, using guesses (intuition), and associative (imitative, modeling) ways of cognition.

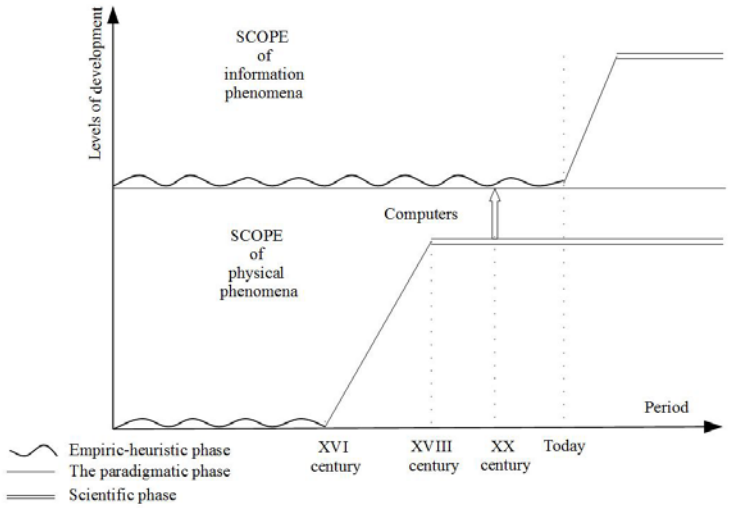

Figure 1 The convergence of knowledge phylogenies [14]

It is evidenced by the unsolved problems of the ontology of information, sign, program, data, organization, etc. Obviously, such state of affairs cannot be a reason for the notorious disintegration of IT, on one hand, and economy and business, on the other hand [15]. To address the problem, it is necessary to eliminate the lag in development cognition in infosphere as compared to physiosphere. The application of computers allowed to accelerate processing of large arrays of repetitive data. However, at the same time, the flexibility of data could not but deteriorate as well as their ability to variate and, as a result of fragmentation - informativity.

5. Vertical of Knowledge - the Convergence of Knowledge Ontogenies

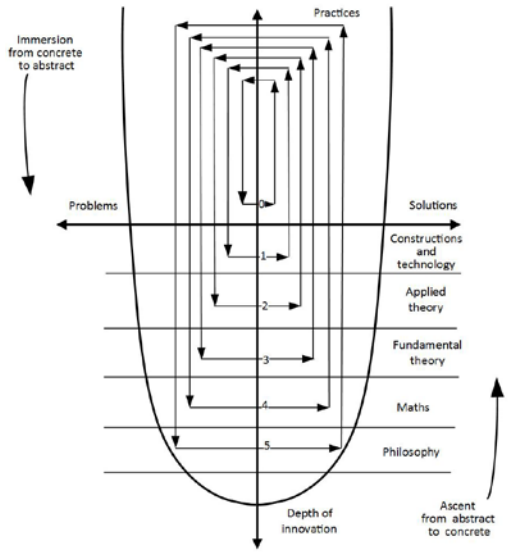

Figure 2 The convergence of knowledge ontogenies [14]

Figure 2 shows the scheme of knowledge ontogeny, based on the considered outcomes of the convergence and divergence of objects and genesis of cognition.

Inside every sphere of phenomena, the process of cognition has specific cyclicity and includes the following levels:

1) Every sphere or its part has own vertical. IT is connected to its own vertical of knowledge, which integrates achievements of physical sciences;

2) Informational practices have their own vertical with similar structure but, except for practice, it has not been completed yet.

3) Vertical of Knowledge for the sphere of phenomena can be decomposed even to a unique problem or innovation;

4) Convergence is a complete unification of the Verticals of Knowledge for natural and conscious spheres in the structure, and their separability (divergence) by content.

6. Parabola of Knowledge - Convergence of Methods of Cognition

The left branch of the parabola of knowledge symbolizes the method of immersion from the concrete to the abstract, in the course of which the paradigms are formed for each level and parabola as a whole. The right branch is an ascent from the abstract to the concrete, in the course of which the found paradigms (abstractions) are used for step-by-step concretization of the required solutions to the problems.

With the help of the vertical and parabola of knowledge, the place of symbolic modeling in cognition of conscious or natural phenomena can be explained. Symbolic model, in contrast to the theory, is a high-level abstraction or analogy, which came from the close sphere of phenomena. It can be used for solving practical tasks, jumping through one or several steps in the vertical of knowledge.

For example, using the language of VIK and Parabola of Knowledge, modeling of conscious phenomena can be compared with jumps through the gap between occasionally chosen abstraction and concrete results of experience. The completed parabola of knowledge is, on the contrary, the stairs, using which the appropriate abstraction can be found at the level of philosophy, and from there through theory and technologies it can rise up from the abstract (paradigm) to the concrete (practice).

7. Quasi-physical Paradigm of Sign Ontology

Noosphere consists of signs. Although, the science about signs, semiotics, belongs to the humanities. Humanities acts indirectly, through human. Their direct convergence with technologies and machines is impossible. There is a need for a quasi-physical science about ontology of sign. Paradigm of ontology of sign (Figure 3) can become its core.

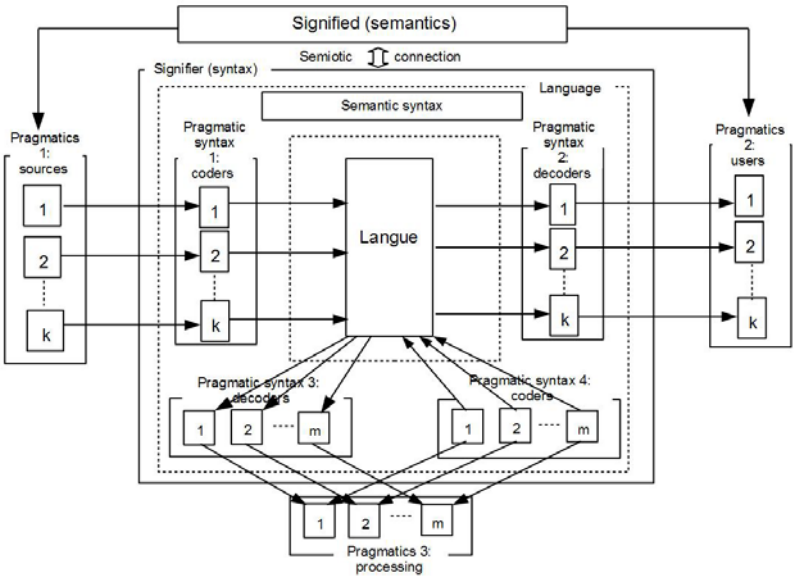

Figure 3 Quasi-physical ontology of sign as a result of convergence of machines and knowledge [16]

Ontology of sign, shown on the Figure 3, is a result of a substantivisation of the functional scheme of sign exchange. An interpretation of the components of this scheme has several important distinctions. First of all, there are semantics, syntax, and pragmatics in the structure of quasi-physical sign, as in the case of traditional semiotic interpretations. Nevertheless, semantics is considered as a real signified part. In case of program, this is computer, which realizes the process of data processing.

If, for instance, the signified part is an enterprise, then it is thought by its statics, dynamics, functioning and dynamics of development. In this case, the signifier or syntax is used to call data. It is assigned to pragmatics the informational needs of a user, his or her responsibilities relatively to database and subject area as well as data processing.

Syntax is divided into groups of data. Some signify the architecture of subject area, the other - its state. Together, they are semantic syntax. Pragmatic syntax describes what is going on with data or with their help, in other words, the functional duties and needs of a user and data processor.

8. Programs and Organizations as Sign Machines

Figure 4 shows the principles of integration of technology and knowledge based on the identified possibilities of their convergence.

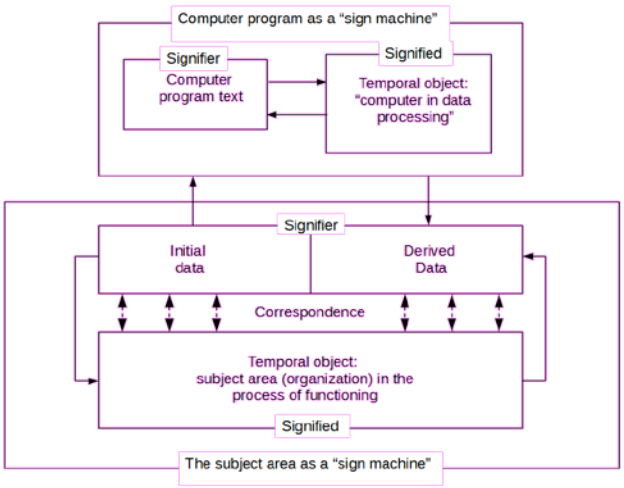

Figure 4 Programs and organizations as sign machines.

In computer program, such as sign machine, the maximal convergence of technologies and knowledge is achieved. Today this happens in the empirically heuristic way in respect of the data, which has low semantic diversity. There is a need in the convergence at the level of understanding in order to create more semantically rich database and programs.

As shown on the Figure 4, the notion of program as sign construction includes the text of program (signifier) and temporal object - computer, which realizes the process of data processing. Data, being signifiers, forms sign constructions itself, together with the subject area, signified by it. The organization can be like this. In the scheme, the text of the program does not depend directly on the subject area, and the data plays the role of a flexible joint between the program as a system of data processing, subject area and user.

The traditional notions have changed in the unexpected and paradoxical way. Computers turned to be inside the program as a sign construction, where the text of program signifies the temporal object - operating computer. Similarly, there are the organizations inside the sign construction where the data is the signifier, and the temporal object that it signifies. The signifiers (text of programs and data) act as the tools to manage the signified.

It is not a formal trick. It is similar to destruction and reconstruction of understanding that Merab Mamardashvili referred to as a precondition scientific revolution [17]. Indeed, such concept excludes the widespread views that the program is a model (description) of the subject area (area of user's interests) in a programming language. Objectively, there are no direct relationship, to be

more precise, correspondence between them. The text of the program should correspond to the processes of data processing in computer, and data - to something that happens in the area of users' interests. They are also semantically related, i.e. through two-step correspondence relation, and physically - through data.

9. Convergence of Spheres and Objects of Cognition

Despite the fantastic, from the perspective of imagination, successes of information technologies (IT), if to use the term "technology" in the meaning of "objective, i.e., scientifically grounded methods of operation" these successes have not yet begun. According to the quasi-physical criteria, technologies emerge when all previous levels of the vertical are completed along the left and right branch of the parabola of knowledge. Therefore, at present, IT is an application of physical data processing technologies to information practices (cognitive, educational, managerial, economic, etc.), i.e., so-called digitization.

It is also the modeling, when a certain abstraction of the higher level (philosophic, mathematical, etc.), universal apparatus (for example, mathematical statistics) or metaphor, borrowed from the adjacent sphere of phenomena (for example, human intelligence), is used for regularization and optimization of information phenomena. Modeling is characterized by absence of a few steps (usually it is the fundamental and applied theory of the issue) between abstraction and practical problem. Therefore, it requires more attempts and efforts, and its performance index is much lower than in case of fully completed vertical of knowledge.

The sectors "artificial intelligence" and "advanced manufacturing" are based mostly on modeling. When they say "artificial intelligence", they actually mean one of two extremely different sectors. One of them implies machine implementation of intelligence, equal to the human one or exceeding it. in this regard, A.V. Zinoviev wrote, "It took many centuries before the logical intelligence was created. We do not consider this story here, but take its result as a given in the form that we can observe in our time. By the way, we observe it not just as the intelligence of individual people, but as the humankind's intelligence, being accumulated in the cumulative language practice of humankind, including the practice of scientific languages. The logical intelligence does not exist beyond these achievements of human language activities at all" [18]. Obviously, such an object is too sophisticated for modeling.

Therefore, there is more or less successful development of "artificial intelligence" nowadays, aiming at machine imitation of individual functions, inherent in animals and human beings. This sector as well as the advanced manufacturing need to be able to handle not only big data, but also semantically varied one, reflecting the subject areas, consisting of various objects.

Concerning the meaning of the term "artificial intelligence", it is better to begin with strengthening of human intelligence, instead of replacing it. Before extracting the meaning and knowledge from texts, it shouldn't be forgotten to put it there. The computer can help human in this respect, not just at the level of words and facts, but also at the level of logic. The outcomes of such work can be used not just at the stage of synthesis, but also analysis as a means of advanced formalization and processing of data.

One more major point in application of quasi-physical approach to conscious phenomena is addressing the problem of overcoming the complexity barrier, caused by semantic variety and variability of data, by the way of solving the paradox of practical productivity of sign sciences including semiotics. The development of flexible structures of data, capable of reflecting the changes in something that it signifies, will solve the paradox of practical productivity of IT in economy and business with much less time consumption. The approach, stipulated by this paper, used to address these problems. Obviously, such solutions will enable making "advanced manufacturing" more steady, flexible, mobile, intellectual, capable of digital transformation, etc.

10. Conclusion

In order to know how to learn, make forecasts, set goals and priorities, one should have a certain

level of understanding of cognition process. In case of quasi-physical approach, the enhanced understanding is achieved by the way of convergence (mutual assimilation) of the areas of phenomena which are traditionally considered to be only natural or only conscious. At the same time, the quasi-physical approach relies on the following provisions, which are relevant for the current stage of infosphere development:

a) conscious (with involvement of consciousness) activity is not the cognition of something new, but the reproduction of something that has already been cognized. Hence, the cognition is not confined in the domain of science, but can take place even in cases, when an entity does not seek for it. This provision is reflected in PIDev model;

b) It is not the phenomena themselves, but their physical and non-physical (more than physical - quasi-physical, or hyperphysical) effects, a sort of "traces" of activity, which should become the objects of the kind of cognition, which leads to scientific understanding and technological change of the world in the shortest way. Georg Wilhelm Friedrich Hegel and Karl Marx saw such an opportunity, while using the concept of modified forms of cognition [19]. This line of thinking was developed by Merab Mamardashvili [10];

c) The world is given to humans in fragmented phenomena. The whole has the essence. One sould overcome this contradiction using differentiation and integration, divergence and convergence. In general, it is performed by decomposing and complexation. In particular, one should consider it as consisting of spheres of phenomena, generated by certain entities - physical, organic, etc. While listing the spheres of phenomena, V.I. Vernadsky called the geosphere (taking into consideration the experience in space exploration, it can be spoken about phisiosphere) and biosphere. He completed this list with noosphere, although failed to find out what kind of essences does it consist of [9];

d) There is a need to find out what entities follow the physical bodies and organisms, how they are combined with other entities. Following A.F. Losev ("Philosophy of the name") [12], Jean Baudrillard (sign consumption) [20], Jacques Derrida (the world as text) [21], such entities are signs. This word is one of the synonyms of polysemantic word "information", which, apart from it, signifies the extent of impact of signs on their recipients. Sign is a unity of its signifying and signified parts. This notion cannot be reduced, as is often the case, just to the signifier;

e) Cognition is a process. In order to understand it, it should be considered historically. The invariant of the process of cognition of basic entities behind similar phenomena is knowledge ontogeny, in other words, the model of Vertical Integration of Knowledge (VIK);

f) Scientific cognition is a regularization of the results of experience in spontaneous formalization of phenomena using constructive and productive abstractions - paradigms. In the infosphere, such objects are databases and computer programs;

g) The paradigm is a result of immersion from the concrete (informational practices) to the abstract;

h) Practical solution is a result of ascending from the abstract (paradigm) to the concrete;

i) The invariant of the processes of cognizing the world as a whole as well as its parts is the phylogeny of knowledge, in other words - the model of Paradigm Innovative Development (PIDev);

j) The physical effect of conscious activity is the thing, all parts of which are physical bodies, and during the whole life cycle they are physically connected between each other;

k) The quasi-physical effect is also the thing, certain parts of which, at certain stages of life cycle, are not related physically, but are in relation of correspondence between each other, which is created and maintained by the subject of activity;

l) Any thing, being physical or quasi-physical, is the implemented knowledge of itself, resulting in inseparability of cognition and economic activity;

m) The cognition at the current stage is the process of convergence (assimilation) of the highest sphere of phenomena (noosphere) with the lower spheres (biosphere and physiosphere, being a part of biosphere). At the same time, none of the highest spheres is reduced to lower ones. The convergence is based on the fact that physical and quasi-physical effects are things, the divergence - on diverse nature of relations between parts of the things.

The convergence of physical and quasi-physical knowledge does not mean that humanitarian, in particular, philosophic knowledge becomes unnecessary. On the contrary, its role as metaknowledge will become even more important.

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References

[1] Meadows, D.H., Meadows, D.L., Randers, J., Behrens III, W. (1972) The Limits to Growth. Universe Book.

[2] Okorokov, V.B. (1998) On the phenomenological foundations of moving sciences (phenomenology and metaphysics). The Philosophical Age. Almanac, 7, St. Petersburg Center for the History of Ideas, 141-147.

[3] Booch, G. (2004) Object-Oriented Analysis and Design with Applications. Addison Wesley Longman Publishing Co., Inc.

[4] What is a program? Historical and Philosophical Perspectives (Online). Available: https://programme.hypotheses.org/files/2018/01/description.pdf (Accessed July 13, 2019).

[5] Solow, R. (1987) We'd better watch out. New York Times Book Review. (Online). Available: http://digamo.free.fr/solow87.pdf (Accessed July 8, 2019).

[6] Srassman, P.A. The Value of Computers, Information and Knowledge. (Online). Available: http://www.strassmann.com/pubs/cik/cik-value.shtml (Accessed July 10, 2019).

[7] Polyakov, M., Khanin, I., and Bormatenko, N. (2016) Quasi-physical approach to solving the semiotics practical productivity paradox. 4th Annual International Conference on Philosophy: Yesterday, Today & Tomorrow (PYTT 2016).

[8] Floridi, L. (2018) The thought that AI will dominate our world is Sci-Fi. Vodafone Institute's event "AI & I".

[9] Vernadsky, V. (2004) The Biosphere and the Noosphere. Airis-press.

[10] Mamardashvili, M. (2008) The Experience of Physical Metaphysics. Progress-Traditsiya.

[11] Losev, A.F. (1990) The Dialectics of Myth. Pravda.

[12] Losev, A.F. (1990) The Philosophy of Name. Pravda.

[13] Eco, U. (1995) The Search for the Perfect Language. Blackwell.

[14] Polyakov, M., Khanin, I., and Bormatenko, N. (2017) Quasi–physical approach to forming the methodological and theoretical base of infosphere development, International Conference on Information Society.

[15] Zachman, J.A. (1987) A framework for information systems architecture. IBM Systems Journal, 26, 76-292.

[16] Polyakov, M., Khanin, I., and Bormatenko, N., and Kosenchuk, S. (2018) Ontology of sign: a key to information and technological advancement of the knowledge society. The International Journal of Technology, Knowledge, and Society, 14, 27-45.

[17] Mamardashvili, M. (1997) The Arrow of Cognition: Sketch of Naturally-Historical Gnosiology. School "The languages of Russian culture".

[18] Zinoviev, A. (2006) Factor of Understanding. Algorithm, Eksmo.

[19] Marx, K. (1951) Theories of Surplus-Value, Part III. Lawrence & Wishart.

[20] Baudrillard, J. (1981) For a Critique of the Political Economy of the Sign. Telos Press.

[21] Derrida, J. (1997) Of Grammatology. The Johns Hopkins University Press.