Information Resource Science

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Theoretical and Methodological Foundations

By

Tatyana Berestova

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INTRODUCTION

Today, informatization has penetrated all spheres of the life of society and the individual. This is an unconditional achievement of computer science, which today is interpreted both as a science and as a field of practical activity. Along with informatization, the phenomenon of “information resources” is widely spread. Representatives of various information sciences have begun to study it. Science informatics includes social informatics. The problematics of social informatics are closest to our scientific interests. We believe that a separate research area is developing within this framework—information resource science. The name information resource science was put forward to designate a new research area, which is considered to integrate and include the knowledge and achievements of information, documentary and communication sciences. We have presented several publications on the rationale for the development of this scientific area in the Russian-language and English-language versions of the Russian journal *Scientific and Technical Information*. The international scientific community has shown interest in these publications. We have received a lot of proposals for publishing articles on the problems of information resources from Asia, Europe, and the USA. Taking into account the interest from different countries of the world in the development of information resource science, Cambridge Scholars Publishing suggested we publish a book on the theory and methodology of information resource science; this offer has now been accepted.

Information resource science, as a scientific area, includes both applied and theoretical knowledge, synthesizing the results of cognitive processes in the humanities and technical sciences. Applied information resource science has been actively developing so far too. This practice-oriented knowledge has largely grown due to technical and engineering developments, and to the development of industry information resource science, integrated into such disciplines as economics, law and others. The achievements of theoretical knowledge in "information resources" are much more modest. Meanwhile, the Russian press has repeatedly recognized the need to develop a theory of information resources. However, it is known that the creation of a theory is possible only after reaching a certain level of applied science, because further accumulated practice-oriented knowledge is used for theoretical generalizations and building certain theoretical constructions.

Today, it is obvious that there is some interest in the theoretical aspects of knowledge in information resource science. There are papers devoted to the problem of creating a conceptual and terminological apparatus of information resource science. There are attempts to identify the laws and patterns of the functioning of the information sphere and information resources in different branches of the universe of human activity. Unfortunately, at the same time, the development of these problems is still completely fragmented in computer science and the sciences of the documentary and communication cycle. There is a genetic unity and functional and technological relatedness between the studied practices of these sciences. This unity could be the basis for combining the results of these sciences into one discipline of integrative knowledge.

The theory of information resource science, like any theory, can be created relying only on philosophical and ideological attitudes. It cannot exist outside the general cultural context. Therefore, its content will be largely humanitarian and social knowledge. As we know, the theory functions as the most complex and developed form of scientific knowledge. The product and elements of theoretical knowledge include scientific abstractions and classifications, identified entities and phrased definitions, objectively applicable laws and patterns, explanatory diagrams and forecasts. All these elements of theoretical knowledge are present in this book and they are all included in the adaptive and evolutionary concept that we have created, explaining the objectivity and the acute historical need for the emergence of information and information resources to form both a separate individual and a separate society as a whole.

The development of science is subject to certain laws that determine the phasing of the development of scientific knowledge and form the distinctive characteristics of each of the stages in scientific development. These questions are most fully reflected in the works by the Russian scientist V. S. Stepin. The main ideas of the philosopher and science theorist V. S. Stepin are also known to foreign scientists, and the notions of “classical, non-classical and post-non-classical science” introduced by him are now used by scientists from all over the world. And as for the development of the theory of information resources, we relied on Stepin’s work. The emergence of its theory marks the transition of information resource science from the classical descriptive knowledge stage to the non-classical and post-non-classical cognition stages. Non-classical science is aimed at studying complex self-organizing systems, but human involvement in the system of creating, transmitting and using information resources allows us to consider the problems of information resource science from the standpoint of post-

non-classical scientific rationality and to diagnose the information sphere as a complex self-developing system. Due to relying on the paradigms of non-classical and post-non-classical scientific rationality, many problems were resolved, such as understanding / explaining the peculiarities of information resources' development as one of the forms of information existence, considering the impact of the environment of information resources on their development. Such an environment is the information space where information laws act objectively, and the cognition of them forms the deterministic section of information resource science.

The total (sum) of certain knowledge cannot be recognized as an already established theory until it contains a certain mechanism for developing knowledge. Such a mechanism is "embedded" in the adaptive and evolutionary concept of information and information resources. Nevertheless, alongside the development of the theory of information resources, there are opportunities for the development of a special methodological section of this area of scientific knowledge. Until now, the methodology, as a section of information resource science, has not been presented in relevant publications. But the development of the theory of information resources, based on the methodological tools of all three paradigms of scientific rationality—i.e. through the use of classical science methods, the attraction of a whole range of approaches born of non-classical and post-non-classical scientific paradigms, as well as through an appeal to the potential of a combination of approaches and methods of philosophical, humanitarian and technical knowledge—has made it possible to generalize the experience of the applied cognitive tools, to prove the importance of methodological pluralism as a general methodological principle of the emerging new scientific area.

When writing this book, our purpose was to lay the theoretical and methodological foundations for information resource science. The purpose was specified in several tasks: to present a conceptual vision of the causes and process of the origin and development of information and the phenomena that it generated; to consider approaches to the creation of the conceptual apparatus of this scientific area and to offer the essential definitions of basic concepts; if possible, to disclose the objective laws in force in the information environment, i.e. in the information space; to reveal the structure of the information space; to give a general assessment of the state of information resource science, as a relatively independent scientific area, and to point out trends in its development; and finally to selectively present the methodological tools used today in the study of information phenomena. When solving all these problems, the author sought to integrate

as much as possible the documentary and communication knowledge and achievements of social informatics into the problems of the theoretical study of information resources.

In information science, at least concerning the documentary and communication sciences, approaches of classical science dominate now. However, the potential of non-classical scientific rationality has already been sufficiently mastered. When developing the adaptive and evolutionary concept, it turned out that some issues could not be resolved solely within the sectoral complex of information sciences. It required a move beyond the social informatics and sciences of the documentary and communication cycle. Thus, the need to attract the potential of post-non-classical science objectively arose. It was characterized by going beyond the sectoral framework of individual sciences, turning to the ideas of universal evolutionism, noospherology, synergetics and using the historical method.

In the adaptive and evolutionary concept of information proposed in this publication, the information sphere is considered a complex self-developing system. When applying the approaches that are commonly used in studying self-developing systems, by going beyond the scope of information science, the objectivity of the formation of the essential properties of information resources was explained, and the need for their further differentiation became clear. Due to the knowledge of the laws and patterns that determine the objectivity of the processes of complicating the information sphere structure, the answers to many questions about the nature of information, information resources, and the information space were found. Moreover, it was possible to recreate the interactional mechanisms of all components of the information space. Thus, the essential definitions of some information phenomena were created. The proposed definitions are abstracted definitions of information, information resources, and other information objects. Creating definitions that prove the existence of extremely abstract concepts is an obligatory stage in the creation of theory. At this stage, opportunities are laid out to formulate demarcation signs of the phenomena under study (information, information resources, and the information space). Then, it is possible to carry out further cognition through their specification and lay the theoretical foundations of the industry and of special information resource science. The adaptive and evolutionary concept of information and information resources is considered an essential part of the theory of information resources. It synthesizes views on information developed by philosophers, information scientists and scientists from other fields of science. We hope that the proposed concept will be fruitful, and that this will be another step for the development of information resource science.

CHAPTER 1

THE ADAPTIVE AND EVOLUTIONARY CONCEPT OF INFORMATION

1.1 Information Genesis: Defining Semantic Information

What is Information?

Having set the task of developing a theoretical section of information-resource science, we realized the need for choosing a particular framework that could be used as a theoretical basis for the concept of "information resources". Undoubtedly, the theory of information resources should be based on the scientific category of "information". Thus, we need a clear understanding of what information is. However, we must admit that this sacramental question has been bothering the minds of philosophers, philologists, science scholars, cyberneticists, computer scientists, biologists, physiologists, document studies specialists, linguists, bibliographers, and representatives of other subject areas for many years. Today, mountains of books and articles on this topic have been written, but scientists have not yet reached a consensus. This is because the word "information" refers to different phenomena, and even if the same phenomenon is being studied, it is revealed (understood) in different branches of science in different ways.

The Russian scientist A. V. Sokolov realized that, in fact, there are several interpretations of the term "information"; one is the representation of information as a mathematical abstraction, it is used in mathematical models created in the field of cybernetic theories and understands information as a tangible signal circulating in real information devices of applied significance;[1] another is the definition of information through the concept of "choice" in biological theories, or the use of the term "information" as a philosophical category and a general scientific concept.[2] The most complete overview of opinions on the concept of "information" is given by

[1] Sokolov A. V., *Filosofiya informatsii* [*Philosophy of Information*] (St. Petersburg: SPBGUKI, 2010), 27.
[2] Sokolov, *Filosofiya informatsii*, 27.

A. K. Voskresensky. He presented all the most common views of computer scientists and representatives of different philosophical schools.[3]

Of course, philosophical and general scientific approaches are the most important basis for creating a theoretical concept. A. V. Sokolov analyzed them separately from A. K. Voskresensky. A. V. Sokolov examines the attributive and functional concepts of information. Within the framework of the first concept, the views of A. D. Ursul are most clearly displayed: "information" is declared an integral property of matter and is considered as a "*reflected diversity*".[4] Within the framework of the second concept there are two schools, called cybernetic and anthropocentric for our purpose. Representatives of the cybernetic school say that information processes can be found in all self-controlled processes: technical, biological, or social. Representatives of the anthropocentric theory consider that human consciousness and human society is the field of information.[5] Such a division of opinions on the issue of "information" is found in the works of V. V. Sanochkin, but he calls these approaches "fundamental" and "vitalistic".[6] Anthropocentrists or vitalists say that information does not exist outside the consciousness, without consciousness, while they emphasize that they are talking about semantic information. Attributivism supporters who consider information an attribute of matter assert:

> ...information is an integral part of nature, but it is not a product of some stage of its development.[7]

Thus, all scientists dealing with the problem of defining the concept of "information" can be divided into two large groups: the first includes those who consider *information an attribute of matter* and recognize its existence in non-living and living nature; the second group includes those who consider information inherent only to the human and regard it as *a product*

[3] Voskresenskij A. K., "The Concept of 'Information': Philosophical Aspects," *Teoriya i praktika obshchestvenno-nauchnoy informatsii* [*Theory and Practice of Social Scientific Information*], Issue 21 (2013): 236–57.
[4] Ursul A. D., *Informaciya: metodologicheskie aspekty* [*Information: Methodological Aspects*] (Moscow: Nauka, 1971), 153.
[5] Sokolov A. V., *Retrospektiva—60: trudy professora A. V. Sokolova dlya bibliotekarey i informatikov* [*Retrospective—60: by Professor A.V. Sokolov for librarians and information scientists*], ed. by S. A. Basov. (St. Petersburg, 1994), 224.
[6] Sanochkin V.V., "On the Possibility of Harmonizing Various Ideas about Information," *Teoriya i praktika obshchestvenno-nauchnoy informatsii* [*Theory and Practice of Social Scientific Information*], Issue 21 (2013): 89.
[7] Sanochkin, "On the Possibility of Harmonizing," 93.

of consciousness, therefore seeing its connection with *evolutionary processes*. We need to decide which opinion is the closest to us, and shall turn first to the connection of information with evolutionary processes.

The processes of evolution have been successfully studied for a long time. Moreover, today, a special branch of scientific knowledge is being formed: "universal (global) evolutionism."[8] Evolution, as a phenomenon of nature and society, is universally recognized, and so in the study of the phenomenon of "information" we can use the doctrine of evolutionary continuity, but we believe that it is very important to point out the relationship of information with genetically earlier phenomena, and at the same time it is essential to separate information from the phenomena preceding its appearance.

Information Genesis

To solve the riddles of the phenomenon of "information" and the phenomena preceding it, it is necessary to analyze the deep-rootedness of these phenomena in biological and social processes, i.e. it is necessary to understand how information emerges. It becomes possible only through excursions to early stages of the evolution of the animal world and the history of society, otherwise, it is impossible to sum up the essential definition of the phenomenon of "information" and to reveal the properties and functions of this extremely complex phenomenon, let alone the knowledge of the objective laws of the functioning of various types of information.

It is known that sometimes it is very difficult to reveal the essence of a phenomenon, because

> ...in the object itself, the essence and phenomenon, form and content are given immediately, simultaneously, and indissolubly, but in the process of cognition they are inevitably dismembered, and are revealed successively, one through the other.[9]

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[8] Chaisson E. J., *Cosmic Evolution: The Rise of Complexity in Nature* (Cambridge, 2001), p. 286.
Ursul A. D., and Ursul T. A., *Universal'nyy evolyutsionizm (kontseptsii, podkhody, printsipy, perspektivy)* [*Universal Evolutionism (Concepts, Approaches, Principles, Prospects)*] (Moscow: RAGS, 2007), p. 60.

[9] Korshunov O. P., *Bibliografiya: teoriya, metodologiya, metodika* [*Bibliography: Theory, Methodology, Methods*] (Moscow: Kniga, 1986), 89.

The cognition of the essence can be carried out using a methodology, the main thesis of which is the following:

> ...it is possible to understand the current state (structure of functioning) of an object correctly only based on its genesis. At the same time, it is impossible to identify a genetically initial point without analyzing the current, most developed object.[10]

In the study of information and its derived phenomena, we will be guided by these most important methodological messages expressed by the bibliographer O. P. Korshunov. The methodology that we have chosen includes a combination of the use of several scientific tools: the study of genesis based on a systemic approach, consideration of the laws of evolution and mechanisms of human adaptation to the world through information phenomena, approaching the concept of the main structural levels, and using a technological or process approach.

The study of the phenomenon must begin "with the simplest cell, considering the object under study in the dialectical unity of its entity and development,"[11] i.e. in our case, we must turn to the time of the emergence of information, which is most often recognized as the result of the reflection of the phenomena of the world in the human mind. Another important methodological message for us is connected with the thesis that the starting point of cognition is always outside the system under investigation. For us, studying informational phenomena, the theory of reflection acts as an initial step in cognition, the approach to it allows us to determine the moment of information emergence that is, undoubtedly, provoked and caused by the human environment. The emergence of information and the original information process can be represented through qualitatively specific connections and relations arising between its structural elements. It is important to note that the described relationships and connections can be restored and expressed only on a dialectically approximate basis, only in an abstract way.

Defining Semantic Information

Several scientists are trying to create a common definition of the phenomena and the concept of "information". In this context, we can name

[10] Korshunov, *Bibliografiya... [Bibliography...]*, 94.
[11] Korshunov, *Bibliografiya... [Bibliography...]*, 192.

the American scientist N. Wiener[12], Spanish sociologist M. Castells[13] and others. Among Russian colleagues who suggested their cognition of the phenomenon of "information", we can name V. M. Glushkov,[14] Y. A Schreider,[15] A. P. Ershov[16] and their followers. The definition posited by A. D. Ursul claims the status of a philosophical definition of information:

> Information is a reflected diversity, as the diversity that the reflecting subject contains about the reflected.[17]

The contradiction of this definition is the following: if the existence of information in non-living nature is recognized, then how can the subject be discussed? (As subjectivity is a characteristic used only for a person.)

While defining the most common concepts, one faces the difficulty of selecting a generic concept, because the generic concept must have an even greater level of generalization than the definitive one, and it must already be uniquely determined. We will try to overcome these difficulties by considering the conditions for the emergence of information, the formation of its properties, and the awareness of the objectivity (necessity) of its

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[12] Wiener N., *Kibernetika, ili upravlenie i svyaz' v zhivotnom i v mashine* [*Cybernetics, or Control and Communication in the Animal and in the Machine*] (Moscow: Sovetskoe radio, 1958), 216.

[13] Castells M., *Informatsionnaya epokha: ekonomika, obshchestvo i kul'tura* [*The Information Age: Economy, Society and Culture*] (Moscow: State University Higher School of Economics, 2000), 608.

[14] Glushkov V. M., "On Cybernetics as a Science," *Kibernetika, myshlenie, zhizn'* [*Cybernetics, Thinking, Life*], ed. by A. I. Berg (Moscow: Mysl', 1964), 53–62.

[15] Schreider Yu. A. "Philosophical problems of Information Science", *Teoriya i praktika nauchno-tekhnicheskoy informatsii* [*Theory and Practice of Scientific and Technical Information*] (Moscow, 1983), 13–21;
Schreider Yu. A., "Social Aspects of Information Science," *Nauchno-tekhnicheskaya informatsiya. Ser. 2. Informatsionnye processy i sistemy* [*Scientific and Technical Information. Ser. 2. Information Processes and Systems*], no. 1 (1989): 2–9;
Schreider Yu. A., "Informatsionnye processy i informatsionnaya sreda," *Nauchno-tekhnicheskaya informatsiya. Ser. 2. Informatsionnye processy i sistemy* [*Scientific and Technical Information. Ser. 2. Information Processes and Systems*], no. 1 (1976): 3–6.

[16] Ershov A. P., "On the Subject of Information Science," *Vestnik Akademii nauk SSSR* [Bulletin *of the Academy of Sciences of the USSR*], no. 2 (1984): 112–37.

[17] Ursul A. D., *Informatsiya: metodologicheskie aspekty* [*Information: Methodological Aspects*] (Moscow: Nauka, 1971), 153.

emergence, as well as through the indication of its purpose and consideration of the possibilities of its inclusion in social processes.

In Russia, the word "information" appeared in the era of Peter the Great, but it was not widespread. Later, when it was time to create management and communication theories, the term "information" was used to explain the essence of such phenomena as management and communication processes, and then the notion of "information" became widespread. Only at the beginning of the 20th century, was the term "information" used in documents, books, newspapers, and journals; it was used in lieu of communication, a message, and data about something. Today, it is often used in this manner in the humanities.[18] In engineering and industrial sciences, information is very often defined through enumeration of the forms of its existence, for example, the famous Russian information scientist V. M. Tyutyunnik believes that signals, data, information, and messages function as elementary particles in the process of communication, and the term "information" as an umbrella concept is used to denote the set of all these elements.[19] Can the umbrella concept be recognized as the definition of a certain phenomenon? We think that it cannot because the essence of the object under study is not clear then. The definition of the phenomenon of information given by V. M. Tyutyunnik reveals the scope of the concept through enumeration of the phenomena that are included in it. However, it does not give a meaningful description of objects that are united under the notion of "information".

It is common practice to create definitions through a description of the process or the performed action. The definition of information given by G. Kastler is a good example of such a definition. This definition is mostly recognized in biology and is as follows:

> Information is a random and memorized choice of one from several possible and equal options.[20]

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[18] For instance, "Information is the contents of a message, data about something… the meaning of data, facts". See: *Bibliotechnaya entsiklopediya* [*Library encyclopedia*] (Moscow: Pashkov dom, 2007), 430.

[19] Tyutyunnik V. M., "On a New Look at the Nature of Information in Social Communication", *Informatsionnye sistemy i processy* [*Information Systems and Processes*] (Tambov; Moscow; St. Petersburg; Baku; Vena: Nobelistika, 2003), Issue 1, 25–30.

[20] Kastler G., *Vozniknovenie biologicheskoy organizatsii* [*Emergence of a Biological Organization*], translated from English by I. A. Raiskaya (Moscow: Mir, 1967), 29.

D. Chernavsky[21] also uses this definition. He is the founder of the dynamic concept of information. The abstract mathematical (statistical) information theory by C. Shannon[22] became a very popular approach used in the study of information. C. Shannon created the formula for the amount of information and defined it as "sublated uncertainty".

A. V. Sokolov provided the results of the study of the phenomenon and the concept of "information" that revealed the contradictions existing in several informational concepts. He challenges the existence of information outside of human thought, and we are persuaded by his words that

> ...the information has only some meaning...if *someone* or something perceives it and responds to it somehow ... We can consider mechanical, thermal, gravitational, electromagnetic interactions as information processes ... and even simulate them in the form of equations. But it will be knowledge of physical reality, gained by people, and not an attribute of matter, that is, it will be social, not material information.[23]

Social information is created in society. Initially, this information was a symbiosis of meanings and signs, the latter were mostly signs of a natural language. Subsequently, people created artificial languages. For our narrative to go further, we would need to single out the search and machine languages among them. According to A. V. Sokolov, both machine and so-called biological information are semantic information, and this information expresses the meanings that are created by man. They can be *biological, or spiritual* in content. Moreover, they can be *a means of simulating* the corresponding processes in *technical devices*. We unequivocally agree with his view. Our study of the above concepts proves that while arguing and giving examples, the authors of informational concepts constantly "slip" into the zone of information processes that take place in human activity, primarily in mental activity.

A. V. Sokolov insists that *only the human can create information*, because only the human has developed consciousness, and that it will always be semantic information. He considers ambivalence the most important characteristic of information, i.e. the existence of information as the unity of the matter and the ideal: meanings belong to the ideal, they are

[21] Chernavsky D. S., *Sinergetika i informatsiya. Dinamicheskaya teoriya informatsii* [*Synergetics and Information. Dynamic Information Theory*] (Moscow: Librokom, 2009), 304.
[22] Shannon C., *Raboty po teorii informatsii i kibernetike* [*Collected Papers on Information Theory and Cybernetics*] (Moscow: Inostrannaya literatura, 1963), 832.
[23] Sokolov, *Filosofiya informatsii* [*Philosophy of Information*], 166.

created by consciousness, but they can be revealed to the world through the matter of communication signs.

> The unity of matter and ideal elements proves the reality of the phenomenon of information.[24]

A. V. Sokolov defines the phenomenon of information as follows:

> ...in its essence, information is an ambivalent phenomenon expressing meanings[25] in the form of communicative signs.[26]

In the definition of information, he introduces the sign as an obligatory element, thereby removing a very common misconception in identifying information and meaning. Equality between meaning and information has been proclaimed by many information scientists. For example, R.S. Gilyarevsky says:

> Computer science is the science of information, which is the content, and the meaning of messages transmitted by people to each other.[27]

Therefore, the definition by A.V. Sokolov is the most convincing among all the above definitions of information.

Then, there is a question about which word should be designated for processes and phenomena studied in engineering, biology, genetics and other natural and technical sciences. Is it possible to use the term "information" for this purpose by specifying its specific characteristic: "biological," "genetic," or "machine"? The question of selecting a term in these cases, of course, should be solved by scientists who study natural phenomena and/or are engaged in designing technical devices. Nevertheless, we are obliged to search for a rational grain in these approaches. Doing so contributes to the objectivity of considering existing opinions, enriching knowledge about information by considering the things inherited from earlier phenomena that can explain its characteristics properly.

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[24] Sokolov, *Filosofiya informatsii* [*Philosophy of Information*], 160.

[25] Meaning is understood as knowledge, skills, emotions, volitional motives, fantasies, i.e. products of individual mental activity that can be communicated to other people.

[26] Sokolov, *Filosofiya informatsii* [*Philosophy of Information*], 257.

[27] *Informatika kak nauka ob informatsii: informatsiya, dokument, tekhnologiya, ekonomicheskie, sotsial'nye i organizatsionnye aspekty* [*Informatics as a Science of Information: Information, Document, Technology, Economic, Social or Organizational Aspects*], ed. by R. S. Gilyarevsky (Moscow: Grand-Fair-press, 2006), 30.

The concept of "reflection" is used as one of the most frequent characteristics of information. Reflectivity is a characteristic of all living organisms, its origins are in the "mirror" reflection of material objects (phenomena) through the organs of the senses. Reflectivity is considered to be an ancestor of consciousness, which can be defined as "a psychic function that has some biological value."[28]

Those animals that have already reached a very high stage of evolution can experience sensitive images that are a mere reflection of fragments of their habitat. This is the form of the connection/interaction of a highly organized animal with the world where it (the animal) lives. As a function of the brain and as one of its most important characteristics, reflectivity is recognized by philosophers, biologists, neurophysiologists, cultural studies specialists, and representatives of many other scientific specialities. Of course, it is difficult to understand the phenomenon of "information" without recognition of the existence of reflectivity as a characteristic of the brain; at least, it is difficult to sum up its definition. However, we understand *reflectivity* as *the first procedure* leading to the formation of the phenomenon of "information".

The definition of information as a memorized choice of one variant from several possible and equal alternatives is often mentioned in biology and mathematical information theory. Sometimes randomness of choice is emphasized. The choice of this or that variant of actions (reactions) is aimed at ensuring the survival of the living organism. The choice is made based on the reaction of the living organism to external exposure. This reaction expresses the desire of the living organism to establish a dynamic balance with the habitat. The establishment of a dynamic balance becomes possible due to the property of irritability. The manifestation of irritability provides a change in the state or location of a living organism. Can we call this process informational?

We think that *the "memorized choice"* is not information, but is rather *a positive or negative marking* of external exposure and changes in the state of the organism that completes the pictures featuring reflected fragments of the world. Negative or positive changes taking place in the organism, like those or other reactions of a living being, are stored in the memory due to conditioned and unconditioned reflexes, and this ensures *the adaptation* of

[28]*Entsiklopediya epistemologii i filosofii nauki* [*Encyclopedia of Epistemology and Philosophy of Science*], Ch. Ed. and compiler: associate member of the Russian Academy of Sciences I. T. Kasavin (Moscow: KANON, 2009), 1103.

the living organism to the habitat. In the future, the actions of this living organism rely on the formed reflex (on the already existing experience). The process of choice is no longer a matter of chance: the choice is regulated based on assessing the possible and most real consequences for certain environmental exposures. Of course, humans have such reactions, like every living organism that has initial reactions/responses to the effects of the external world. Their initial choice can also be accidental, but later when a similar situation occurs, the human tends to make a choice consciously, i.e. deliberately. In the process of evolution of living matter, the property of irritability develops into mental processes. In the case of homo sapiens, this is due to the physiological features of the structure of the nervous system and brain. However, these arguments are not enough to make a definition of the phenomenon of "information".

Analysis of the ways of creating definitions shows how it is a common practice to make a definition based on the assumption that the phenomenon being defined is an independent phenomenon. In this case, the definition of the phenomenon's structure or the enumeration of more particular manifestations or forms of its existence is often used. However, *the essential definition* of the phenomenon must reveal *the nature* of the phenomenon being defined. It must also reveal *the reason for its emergence*, and reflect *the mechanism* that ensures its *integration into a more extensive system*. The reasons for the emergence of a phenomenon are typically outside the system where the phenomenon under study functions. When creating the definition of the phenomenon under study, apart from indicating the reasons for its emergence, it is very important to disclose *the difference* between the phenomenon being defined and *the original*, *generic one*. For this purpose, generic differences are introduced.

A more extensive system (metasystem), within which the phenomenon of information emerges and functions, is the system "Man—the World (habitat/ life environment)." The world around is heterogeneous. It consists of the natural world and the social world, which includes the spiritual world. Initially, the phenomenon of "information" appears in this dual system as *an intermediary*, ensuring the connection of the individual with the real world, and its purpose is to ensure the survival of the individual. N. Wiener wrote that information is "a designation of the content obtained from the outside world in the process of our adaptation to it and adaptation of our senses to it."[29]

[29] Wiener N., *Kibernetika* [*Cybernetics*], 19.

Like N. Wiener, we conclude that information is a means/tool that, first, ensures the survival of people, but then through information, they cultivate the territories where they live. In the process of evolution, information is used to adapt not only to the material world, but also to the world produced by the society and by the consciousness of the individual, i.e. to the world of ideas and fantasies, emotions and wills that are products of an individual's psychic activity and that are referred to as "senses". *Adaptation can be biological and social.*

> Man is an adaptive and adapting being. The adaptation of a person is a two-way process:[30]

an individual adapts to living conditions and/or adapts conditions to his needs, and with an ideal interaction, a balance is achieved between the person and his environment.

It is important to note that any individual, adapting to the material and spiritual (intellectual) environment of his habitat and adapting them to himself, enters developmental processes. In addition, social progress—including scientific and technical progress—is formed based on the development of individuals. The constant renewal of the realities of the natural and social world causes the continuity of the adaptation processes of all living organisms, but the human copes with the task of functioning in a constantly updated world more successfully than other organisms do, principally because he transforms the environment; he creates a *world to fit him and to meet his needs.*

According to the system approach, the emergence of any new phenomenon is always conditioned and directed at solving a problem, but the phenomenon that has appeared can become a relatively independent phenomenon and generate new phenomena with a common nature, and at the same time have differences in comparison with the original one. This is exactly how the species diversity of our world emerges. All the above-mentioned is utmostly relevant to the phenomenon of "information". The first conditional acts of information creation were solutions to problems related to human survival, to safety, maintaining the vital functions of the body and meeting the natural need for propagation. Furthermore the phenomenon of "information" has become a common instrument of human activity.

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[30] *Entsiklopediya epistemologii i filosofii nauki* [*Encyclopedia of Epistemology and Philosophy of Science*], 23.

Therefore, the foregoing allows us to clarify the definition of information suggested by A.V. Sokolov. The clarification of the definition is required due to the need to indicate the reasons for the emergence of information and to show the mechanism of its occurrence. In our formulation, the essential definition of information is as follows: **Information is a means of adapting a subject to the outside world (natural and social) through created/appropriated meanings expressed by communicative signs.**

Many adaptation mechanisms have been created; it was important for us to give *a specific difference in information adaptation* from other ways that living organisms adapt to their habitats. It seems that this definition solves the problem.

We are sure that the essence of the phenomenon of "information" is covered in this definition. Our confidence is generated by the repeatedly proven methodology of cognition through restoring the genesis of the phenomenon, and through appealing to the procedures of rising from the abstract to the concrete; namely, the reproduction of the movement from the historically primary to the historically derived, from the simple (original) to the complex:

> The very history of the object produces abstractions, which retain the essence, freed from transitory historical content[31].

Historical (evolutionary) development of a phenomenon often "blurs" its primordiality, disguises the reasons for its emergence, and sometimes does not allow us to reveal the essence of the object of study immediately, to reflect the essence while defining it. Through overcoming problems with the help of information, we explain the evolution of information, and how this process is inseparably connected with the evolutionary development of the human and its society.

Defining information as a means of adaptation, we must declare that *human transformational activity* has become the most important and most effective *means of adaptation*. This activity emerges as a response to needs. It ensures the satisfaction of physical and social (including spiritual) needs. Under the influence of the development of individuals and society, this activity is differentiated simultaneously with the differentiation of information, which is an obligatory tool of activity.

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[31] Korshunov, *Bibliografiya...* [*Bibliography...*], 195.

A human adapts to the conditions of the course of activity through information. The activity can vary in purpose and complexity. The more complex this activity is, the more the specific preparation of its performer is required. And such preparation goes through the creation and use of information, therefore all the information processes accompanying the activity can be characterized in different ways, depending on the purposes and content of the activity. But, they are *adaptive*. *Information is a means/tool for adapting a human to a particular activity.* It is an obligatory element of the evolution of man and the evolution of a lot of things that he produces.

1.2 The Properties of Information: Its Essential and Specific Functions

The Notion of "Function" Concerning Information Phenomena

Theoretically, having recreated the conditions preceding the emergence of information, we can reveal the objectivity and organic nature of the formation of *generic characteristics/properties of information*, which the phenomenon under study derives from phenomena preceding its genesis. Furthermore, these generic properties will be in all phenomena derived from information, although it may not always be explicit. The properties of information are often shown indirectly, implicitly. Properties that are demonstrated externally are named *functions*. In this case, a function is defined as

> ...an external manifestation of the properties of an object in a given system of relations.[32]

This understanding of functions and properties enables us to consider them in correlation.

The nature of the phenomenon can be hidden because the phenomenon has all the following functions:

- functions inherited from the previous state of the object (called generic, inherited)
- the essential function, which marked the emergence of the phenomenon

[32] *Filosofskiy entsiklopedicheskiy slovar*' [*Philosophical Encyclopedic Dictionary*], ed. by V. S. Morev, 2nd ed. (Moscow: Sovetskaya entsiklopediya, 1989), 719.

- new emerging functions that arise based on the properties and qualities of an object
- functions derived from essential ones (including social and/or applied/technological functions)

The repetition of a situation leads to fixing properties and qualities in the form of functions. In the future, it can become the *essence* of a new, relatively independent phenomenon, thus, it explains the evolution process.[33]

Our article "The Properties of Information as a Potential of its Hierarchic Functioning and Diversity of its Types"[34]tries to reveal the *functions of information* that can be derived based on its properties. The properties of information are most often enumerated in a nominal order in computer science, while their influence on the functions and types of information is not revealed. Meanwhile, the functional approach is known to

> make it possible to study language, and cultural, social, and psychological phenomena at the interdisciplinary level, removing artificial barriers between different disciplines of the humanitarian cycle.[35]

Sociology considers a function as a process that is performed by a part concerning the whole or as a role that is played by a social institute for society.[36] In the social sphere, an external function can be regarded as the accumulated form of the requirements of society (a consumer) to a social institute. Any type of information may obtain derivative functions, which are based on its essential function.[37]*Derivative functions* can act as the

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[33] Berestova T. F., "Document: Methodological Foundations of the Study, Prehistory of Emergence, Essence and Phenomenon," *Nauchnye i tekhnicheskie biblioteki* [*Scientific and Technical Libraries*], no. 10 (2011): 42–54;
Berestova T. F., "Functions of various information types as a basis for multilevel information space", *Scientific and technical information processing*, no. 4, Vol. 36 (2009): 219–28.

[34] Berestova T. F., "The properties of information as a potential of its hierarchic functioning and diversity of its types," *Scientific and technical information processing*, no. 1 (2013): 39–45.

[35]*Entsiklopediya epistemologii i filosofii nauki* [*Encyclopedia of Epistemology and Philosophy of Science*], 1101.

[36]*Filosofskiy entsiklopedicheskiy slovar'* [*Philosophical Encyclopedic Dictionary*], 751.

[37] Motulsky R. S., *Biblioteka kak sotsial'nyy institut* [*The Library as a Social Institution*] (Minsk: Belarusian State University of Culture, 2002), 374;
Sokolov A. V., "Social Functions of Library and Bibliographic Activity", *Nauchnye*

internal or *technological functions* of a phenomenon, which originate based on information. For example, the functions of an information-communication institution, which are materialized as the organizational functional structure of a certain institution and are implemented through its subdivisions.[38]

Many studies based on using the system approach and reproducing the genesis of different phenomena have shown that the world is functional and this functionality was initially generated by the need to satisfy primitive physiological needs for the survival of a separate subject and/or conservation of a biological species. The pyramid of both material and sociogenic/spiritual needs grows on this foundation. Today, it is generally recognized that the greater part of human needs is formed and satisfied by the compulsory involvement of information, which a subject creates himself or borrows from somebody. Each *new phenomenon* in the pyramid of needs or methods for their satisfaction can become *the expression of a new essence* since it has its essential function, but the function can emerge if a phenomenon/subject has necessary properties. When a new phenomenon arises, new functions, which were absent in genetically preceding phenomena, are formed in it based on the essential function. For the subject we expound, it is most important to consider the attributive properties of information, i.e. the properties without which it does not exist;[39] new functions are formed on their basis, and the multiplicity of properties and functions makes information *multifaceted*.

We found out that the nature or generic functions of a phenomenon are formed based on its generic properties, and the properties themselves are inherited by the phenomenon from its previous states: *the specific function* arising at the birth of a new phenomenon explains the reason for its emergence and its purpose. *The totality of generic and specific properties is the essential (substantial) characteristic of the phenomenon under study*. It is common knowledge that nothing passes away or disappears without a trace, but rather remains in the phenomenon in the sublated or "hidden" form. Essential characteristics remain throughout the entire period of the existence of the phenomenon. With the destruction of the essential properties of the phenomenon under study, it ceases to function, or even

i tekhnicheskie biblioteki SSSR [*Scientific and Technical Libraries of the USSR*], no. 6 (1984): 19–27.

[38] Motulsky, *Biblioteka kak sotsial'nyy institut* [*Library as a Social Institution*], 156.

[39] *Sovetskiy entsiklopedicheskiy slovar'* [*Soviet Encyclopedic Dictionary*], ed. by A. Averyanov (Ch. Ed.) [et al.] (Moscow: Sovetskaya Entsiklopedia, 1986), 89; Berestova, "Functions of various information types as a basis for multilevel information space", 92.

disappears. The awareness of the importance of generic properties of information makes us dwell on their characteristics in more detail.

The Properties of Information Making It One of the Adaptive Tools

Information has the property of *communicativity*: firstly, due to a special property of the brain—reflectivity—the individual's contact (communication) with the world of nature and society is realized through information. The connection of a living organism with its habitat is an obligatory condition for its survival. All living organisms have this connection as the basis of their adaptation to the environment. It is provided by the property of irritability. Thus, a human's connection with the world around him is *inherited* from the previous forms of evolution and becomes the basis for the formation of adaptive mechanisms of his behaviour. It is inseparably connected with the comprehension of the surrounding world through the emergence of human thought activity. Secondly, *communicativity* is manifested in the fact that a person transmits information, thus, the communication activity of a person is formed. The phase of information transfer during the development of society creates special communication systems and entire branches of the national economy/business that specialize in transferring information. The most vivid examples are the activities of educational institutions, media organizations, the leisure industry and the sphere of art.

As we see, the communicative nature of information allows a human to survive, because initially, information has *an auxiliary purpose*, it is *a tool* of the interrelation between the individual and his habitat. It is a tool of comprehension and designation of the phenomena of the world around him. At the beginning of evolution, the adaptation processes through comprehension extend only to the natural environment; then, this approach is applied in the social environment, in the spiritual life of the individual and society. Thus, an auxiliary instrumental property is formed for information through the emergence of semantics.

As a means of adaptation, information possesses the property of *value*. Every living organism has this property. The property of value emerges at very early stages of the evolution of living nature. It is expressed in the *selection* of something significant for a living organism from everything that is "mirrored" through the senses/feeling, including sensory images. Neuroscientists and neuropsychologists assume that even

> ...the simplest subjective characteristics of complex physical phenomena of the surrounding world have a high adaptive *value* since they allow the body to react quickly and adequately to events in the environment.[40]

> The selection of sensor signs begins at the level of receptors and ends with a sensation, image, or simple symbolic representation in the brain cortex.[41]

All the objects that are perceivable by humans are by no means transformed into semantic informational objects (i.e. the objects given a meaning and marked with a sign), especially among documented objects, i.e. into fixed information; only what is important and valuable for the interaction of an organism with the subject world is constantly selected from the entire assembly of sensory images. The selection mechanism is not clear yet. Neurophysiologists and neuropsychologists are trying to reveal it. Nevertheless, we can already say that the selection is mostly done on a trial basis, by trial and error, and also by a later mechanism of associations. However, it is clear that meaning is only given to some images, they are reformatted into a sign-name, into a concept. That is how semantic information appears. Evaluation (selection) mostly takes place when the created information is stored, since a subject of the information process keeps by no means everything, but only valuable, significant things that can be useful and claimed in the future. By creating information, selecting and keeping it, a person works out methods for conserving himself as an individual, as a biological creature, and as a member of society.

Creating meaning is the most important procedure of an information process, and it is the meaning, as an obligatory characteristic of semantic information, that allows this information to be one of the resources of human activity. The ideality of meanings, which is among the constituents of semantic information, determines such properties as imperishability or existence without time restriction. It is the property which is expressed in the bright phrase: "Manuscripts do not burn." The moral ageing of information may be considered as a dialectic antipode of imperishability. However, the property of the imperishability (ideality) of information predetermines the possibility of *updating* information, which was formerly recognized as outdated. It is not meanings that are decayed, it is signs that are used to express meanings, and the material carriers of signs as well. A person can show the property of the value of information by selecting

[40] Sergin V. Ya., "Subjective Reflection of the World: Neurobiological Mechanisms and Meaning", *Otkrytoe obrazovanie* [*Open Education*], no. 1 (2009): 34.
[41] Sergin V. Ya., "Nature of Consciousness: Neural Mechanisms and Meaning", *Otkrytoe obrazovanie* [*Open Education*], no. 2 (2009): 42.

valuable things and endowing them with semantics (content, meaning) and then encoding them via a sign derived from semantic information in subsequent phenomena. This property appears as an evaluativity and selectivity in further phenomena. As for library science and bibliography, the description of the transformed manifestation of these properties can be found in publications devoted to the evaluation function of bibliographic information, the selective function of the library, the theoretical grounds for selection technologies in stock science and in bibliographic activities such as compiling, etc. Due to the developed nervous system and the inclusion of the individual in social and spiritual processes a human's evaluation departs from the verdict "useful or dangerous for the organism," and the evaluation becomes multidimensional, multi-optional, meaningful, brightened by all the characteristics that reflect the personality and sociality of the subject.

It is known that, together with the emergence of mental processes as a result of the reflection of the surrounding world (habitat), even living organisms of a lower stage of evolution have sensory images. Highly organized animals have sensory images that function reliably and properly, ensuring their adaptation to the habitat. A human can preserve (keep) the whole world in consciousness in the form of an information analogue that can be true or distorted.

Information Properties Gained in the Process of Formation of this Phenomenon

The information analogue of the world, like the world itself, can be considered a complex self-developing system. The information analogue of the world allows an individual to conduct mental operations using the sign-semantic designation of real objects as models. That is the way information *modelling* is formed—another property that becomes generic for subsequent information phenomena. The creation of a model is impossible without *ordering*, *organizing, structuring*[42]—and these are generic properties of information too. We find such properties as communicativity, instrumentality, modelling, ordering, organizing, and structuring in subsequent forms of *information evolution*. These properties are often manifested in the form of derivatives or social functions in various types of semantic information; for

[42] Nesterov A. V., "Philosophy of Information," *Nauchno-tekhnicheskaya informatsiya. Seriya 1. Organizatsiya i metodika informatsionnoy raboty* [*Scientific and Technical Information. Series 1. Organization and Methods of Informational Work*], no. 2 (2000): 1–9.

example, in the bibliography, these phenomena are recognized as functions of bibliographic information.[43]

With the emergence of consciousness and mental activity, the communicative ability is realized not only based on sensory images but also through mental (ideal) images (*meanings*), which are schemes of objects that express their basic meaning. The meaning is recorded by corresponding symbols—kinematics, gestures, onomatopoeia, sound-imitating pre-speech, exclamations, and then mytho-semantic, intellectual images including words. The sum of these associative symbols and links is coded with the help of *signs*. The storage and translation of the supra-biological programs of human life-sustaining activity imply the diversity of sign and code structures, which fix and convey a constantly renewed social experience. Thus, the creation of the material world took place simultaneously with the creation of the ideal (semantic) world coded by material signs and symbols. Today these sign systems are first considered natural and artificial languages, including the languages of art.

Science tends to consider society and man as *a self-developing system*. For synergetics, the starting point for the emergence of such a system is two contradictory mutually moving sides and the presence of an intermediary link formed during their interaction.

> An elementary simple system including two mutually exclusive contradictory sides whose mutual transition is carried out through the mediating link formed in their interaction, for synergetics, is the starting point of self-organizing systems.[44]

A chain of "real world—a man" is that simplest system, and *information* is an intermediary between the above contradictory components. The incipient consciousness at the beginning of human evolution was *chaotic*. It was an imperfect and unsystematic complex of reflected "pictures" of the world and a set of poorly interconnected non-verbal signs, i.e. these were already separate phenomena of information. There was a lack of ways for conveying semantic meanings that were necessary to implement reliable communication,

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[43] Korshunov O. P., *Problemy obshchey teorii bibliografii* [*Problems of A General Theory of Bibliography*] (Moscow: Kniga, 1975);
Morgenshtern I. G., *Obshchee bibliografovedenie* [*General Bibliography*] (St. Petersburg, 2006), pp. 57–59.

[44] Poddubny N. V., *Samoorganizuyushchiesya sistemy: ontologicheskie i metodologicheskie aspekty* [*Self-Organizing Systems: Ontological and Methodological Aspects*] (Rostov-na-Donu, 2000), 10.

to form and develop a human community. Non-verbal means of transmitting meanings (facial expressions, gestures, and shouts), which different representations of ancient people had, could be transmitted for very short distances. Moreover, facial expressions, gestures and shouts were not always unambiguously interpreted (understood). This form of communication, until a certain point in the existence of the system, was a perfectly ordered phenomenon. Communication acts through postures/gestures and facial expressions were the main forms/instruments of interaction for a long time. Speech appeared about 123 thousand ~ 40,3 thousand years ago.[45] Sensible "pictures" of the reflected world accumulated and became more complicated. However, the possibilities of transmitting non-verbal signs were very limited. The fixation of certain meanings behind the sound signs "broke" the established non-verbal communication. The emergence of words provoked chaos in the existing non-verbal communication and the words that emerged became points of fluctuation. Information became a means of overcoming *objective* contradictions between man and nature, but the forms of information changed. The appearance of points of fluctuation, born by word-formation, brought chaos into non-verbal communication, and at the same time, the appearance of fluctuation was the ***beginning*** *of the end of chaos*. The mass manifestation of verbal information phenomena in individuals led to deep necessary connections emerging against the background of a multitude of random factors influencing the life of society. Such connections allowed a full-fledged language structure to emerge. According to the post-non-classical paradigm world view, chaos

> ...as a state derived from the primary instability of interactions ... may cause spontaneous genesis of structure … but the set of possible trajectories of the evolution of the system is defined and limited.[46]

Meaningful sound phenomena were the points of fluctuations in primary society. They also provided an opportunity to create a new sustainable communication system. These were the circumstances that could have resulted and that actually resulted in the emergence of different alternatives of existence of originated societies: a) the existence of a society without a full verbal (lexical) language, and b) the existence of a society that creates

[45] Grinchenko S. L., "Historical Models of Time and its Acceleration", *Vestnik Chelyabinskoy gosudarstvennoy akademii kul'tury i iskusstv* [*Herald of Chelyabinsk State Academy of Culture and Arts*], no. 3 (31) (2012): 4–45.

[46] Chmykhalo A. Yu., "Philosophical Problems of Science and Technology", *Tomskiy politekhnicheskiy universitet: korporativnyy portal* [*Tomsk Polytechnic University: corporate portal*]. http://potal.tpu.ru:7777/SHARED/s/SANICHTOM/academic/Tab/Kurs_lekcij_po_discipline_FPN.pdf (date of access: 04/25/2018).