Informatics and Human Creation

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Abstract—Creative work (as well as creativity itself) is one of the attributes of the human essence. The creation characterizes the consciousness and self-consciousness of the person to the same degree as the reflection of reality does. Art and scientific cognition are the kinds of creation that play an especially large role in the development of world civilization and culture. Information is a basis in both of them; however, intuition is of peculiar importance as well. Modern informatics gives researchers considerable methodological means for investigation of creation as a particular phenomenon of human activity.

Keywords: creation, consciousness, heuristics, art, science, information, intuition

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INTRODUCTION

History shows that for some time the development of mankind has been moving forward in impulses that have a more or less definite dominance. Of course, the process as a whole is complex and qualitatively diverse, internally heterogeneous; however, usually the prevailing aspects can still be identified in it. It is these that make up the characteristics of each period. The first and second world wars, the struggle of colonial peoples for independence, the “cold” war, the global ecological crisis, the formation and deepening of the ideology of sustainable development can be illustrative examples.

The number one topic for the modern world community has become the pandemic caused by the COVID-19 coronavirus and the economic depression organically associated with it on the planet. All other problems that worry people and have meaning for them, in one way or another, fall into the general semantic context set by the meaning of this defining dominant issue.

However, along with this specific feature of the current historical stage in the development of human civilization, it necessarily contains features of a different, so to speak, eternal character. This is what inevitably accompanies humanity in all epochs, which is associated with the very nature of man.

In this article, we would like to draw the reader’s attention to one of them, creativity; in the most general interpretation it is “an activity that generates something qualitatively new, which has never been before. Creativity can be viewed in two aspects: psychological and philosophical. The psychology of cre-

ativity explores the process, the psychological “mechanism” of the act of creativity. Philosophy considers the issue of the essence of creativity, which was posed in different ways in different historical epochs” [1, p. 670]. To this it is necessary to add that creativity is also investigated by other branches of knowledge: the physiology of higher nervous activity, logic, cybernetics, mathematical linguistics, etc. Today, informatics should be mentioned among them. It is the informational aspect of creativity that will be the primary object of our proposed analysis.

Another feature of our approach to the study of creativity is constant attention to the problems of integration processes in modern science and social practice. This means that one should not take the results of the study of the phenomenon of creativity in each specific area of knowledge into account separately, in isolation from all others. For individual observed facts and features, it is always necessary to see and consider the integral image of creativity, considering all possible achievements of both the science of our time and the practical activities of mankind.

It is on this methodological basis that heuristics has long been developing as a special scientific discipline about creative thinking [2, 3]. The term comes from the ancient Greek word “heuristic” (looking for, discovering, finding). On the one hand, it is associated with the era of antiquity, with the names of Socrates and Archimedes. On the other hand, with the deepening of the scientific and technological revolution in the second half of the 20th century. and nowadays, with the development of technical cybernetics and information technologies of artificial intelligence. Today, in the public consciousness, of course, the semantic

content of this term, determined by the second of these options, completely prevails.

The general problematics of creativity, of course, is far from being limited to aspects that are most often included in the content of the concept of heuristics. Therefore, it is logical to start with the traditional foundation of the theory of creativity, as it was created by centuries of development of philosophy, psychology, history, and cultural studies.

CONSCIOUSNESS: REFLECTION OF REALITY AND CREATIVITY

The border that fundamentally separates humans from the animal world (including the great primates living in the nature of our planet) is determined primarily by consciousness. In its most general form, it is the ability of the ideal (i.e., nonmaterial) and active reflection of reality based on mental processes in the human brain [4]. It is clear that thus consciousness first of all belongs to the category of attributive characteristics of a person as a special phenomenon of the universe.

The nature of human consciousness cannot be explained at all without referring to the concept of reflection, and it, in turn, is logically connected with another important concept, interaction [5, pp. 18–20]. A person constantly interacts with many objects of the world around him, and their properties are inevitably reflected in him, in his nervous system. It is on this path that a person becomes a subject of consciousness (as a reflection of reality). In each individual case, the properties of the object (displayed) in a certain form are expressed in the properties of a person, i.e., subject (reflecting), and this act of interaction with one another generates in a person an ideal image of the factor influencing him.

If the form of reflection is essentially inadequate to the nature of the reflected object, then consciousness distorts reality. In cases of very large and fundamental discrepancies, it is necessary to assume that the subject of consciousness has a deviation from the mental norm (up to mental illness). However, it should be noted that this assumption is not always justified. If we are talking about emotional and artistic natures, about people of art, perhaps this is due to fantasies in creativity or new methods of stylizing reality. As an example, society has long been sympathetic to paintings in which tree leaves are blue or women fly with fish tails. To assess the scale of such a phenomenon as surrealism in painting, it is enough to recall only one name: Salvador Dali.

And yet, the basis of consciousness (and, consequently, of human creativity) is undoubtedly a reflection of reality, without which there is no human as a thinking being at all. However, this is not recognized, as is known, by all researchers of creativity and, more broadly, by philosophers, scientists, and representa-

tives of the intelligentsia. “The main argument put forward against the principle of reflection is usually the statement that reflection is allegedly absolutely incompatible with creativity, that the theory of reflection refutes the activity of the subject” [6, p. 5]. However, this is not so: it does not refute it. At the same time, without interaction with the external world, consciousness and creativity would be impossible already because in this case there would be no subject as a person.

The essence of the question is that consciousness is not just a reflection of reality by a person; however, a reflection is always necessarily active, i.e., basically creative. In other words, we are not talking about the reproduction of what is, not about absolute copying, reproduction of reality as such. Consciousness actually means “the highest level of human mental activity as a social being. The originality of this activity lies in the fact that the reflection of reality in the form of sensory and mental images anticipates the practical actions of a person, giving them a purposeful character” [7, p. 622]. This means at the same time the functional nature of the reflection of reality by a person.

The nature of man is such that already in his perception of the world, in sensations, feelings, emotions and thoughts, he not only displays a purely reflective ability, but also involuntarily embodies transformative potential. Moreover, in this process, one way or another, very many characteristics of the subject and the circumstances of his life are expressed, for example, his age, ethnicity and social status, upbringing, general culture, professional profile, level of knowledge and qualifications, range of interests, basic foundations of worldview and life strategy, pressing tasks, and even his mental state at every moment.

The creative activity of consciousness as an important feature of the specificity of a purely human form of reflection of the world is a fundamental feature of the entire problematics, on the one hand, the doctrine of consciousness, and on the other, the theory of reflection. Proponents of this position understand consciousness as “what is understood is not just mental reflection, but the highest form of purposeful mental reflection of reality by a socially developed person. It represents such a function of the human brain, the essence of which lies in an adequate, generalized, purposeful and active reflection and constructive and creative alteration of the external world, which is carried out in a speech (or generally in a symbolic) form, in linking new impressions with previous experience, in the selection by a person oneself from the environment and opposing oneself to it as a subject to an object” [4, p. 80]. It is clear that human creativity is meaningfully connected precisely with the creative activity of consciousness as its necessary prerequisite. Before one can create something new (or change existing things) in reality, one needs to do it mentally, in the brain of the creator.

From a purely formal point of view, these two categories, creativity and reflection (taken by itself, as such), mean opposites. This is logical: like all phenomena of reality in general, consciousness is internally contradictory, it exists in the unity and struggle of opposites.

The contradictoriness of any real phenomenon is objectively manifested in many aspects. The more complex the objects are, the more and more obviously they can be identified. In this respect, one of the main aspects of consciousness is the contradiction between the materiality of its physiological basis and the ideality of the image that appears in the brain [4, pp. 34–77]. The fundamental nature of this contradiction is manifested, for example, in the traditional view of man as the unity of soul and body. In this context, we recall that the very common scientific term “psyche” originates from the ancient Greek word *psyche*: soul.

“Being a property of highly organized matter, the brain, consciousness acts as a conscious being, a subjective image of the objective world, a subjective reality, and in epistemological terms, as ideal in contrast to the material and in unity with it ... In psychology, consciousness is interpreted as a special, highest level of organization of mental life of the subject, distinguishing himself from the surrounding reality, reflecting this reality in the form of mental images, which serve as regulators of purposeful activity” [7, p. 622]. Human creativity (in the broadest sense of the word) is a synonym for just such activity.

It should be noted that active reflection of reality is not the exclusive prerogative of man; it quite obviously characterizes, for example, the behavior of animals. This means, in particular, that human consciousness did not arise by itself from scratch. Science has long come to the conclusion that different types of active reflection of reality originated with life, at the level of living matter, and it presupposes the need for communication with certain forms of self-government of living organisms. The emergence of man meant a qualitative leap in the development of this process: higher nervous activity became possible, the “central headquarters” of which is the human brain. The neurophysiological activity of this most important organ acts as the material substrate of the human psyche, which manifests itself in any ideal phenomena. The psyche unites the totality of any images (sensory and mental), memories, thoughts, emotions, feelings, desires, hopes, plans, ideas, intentions, etc.

It must be remembered that there are certain purely physiological conditions for the adequacy of the mental reflection of the world by man. “Normal mental activity of the brain presupposes its waking, active state, which is caused and maintained in the presence of afferentation, that is, the influx of countless nerve impulses from the sense organs to the brain. If there is no afferentation (say, when the brain is artificially isolated), then the brain does not produce mental phe-

nomena ... The reticular formation associated with the mechanism of influence plays an important role in maintaining the awake state of the brain and thus in regulating the clarity of consciousness. Its dynamics mainly affects the “readiness for action” of the cerebral cortex” [4, p. 42]. There are other similar conditions and restrictions. Thus, the inextricable link between the material and the ideal constantly makes itself felt in the mechanisms of the functioning of consciousness.

Any act of real human creativity (no matter what sphere of social activity we are talking about, science, technology, art, politics, economics, etc.) is completely impossible, simply unthinkable without the painstaking and multifaceted work of the consciousness of people involved in it, one, several or many. It is difficult to imagine all aspects of his influence on society, after all “the most important function of consciousness is the mental construction of actions and the foresight of their consequences, control and management of the behavior of the individual, and her ability to be aware of what is happening both in the environment and in her own spiritual world. Consciousness is the relationship of the subject to the environment, which means the inclusion in the act of consciousness both of the entire life of the subject in its uniqueness and originality, as well as his direct experience of the system of his relationship to reality” [7, p. 622]. Consciousness, without exaggeration, accompanies literally the entire life of mankind on Earth (and for some time now also in space), literally at every step.

Another facet of the problem of consciousness is associated with the idea of V.M. Glushkov that thinking is information modeling of reality [8, 9]. Thinking is a category that is close enough to consciousness (these two terms are sometimes even used as synonyms, although in this case the synonymy, of course, is not absolute). However, the fact that thinking, no doubt, is also organically linked both with reflection and with creativity is of decisive importance. Analysis shows that consciousness as a whole with the same grounds can be characterized as information modeling of reality: after all, not only purely mental, but also its sensory-emotional components, in essence, are modeling ideal images of real situations and circumstances. However, these are not only images of what took place earlier and is happening in the present; these models also pave the way into the future due to the anticipation of the subject’s activity. “... Consciousness is not just an image, but an ideal form of activity focused on the reflection and transformation of reality” [4, p. 80]. In other words, it is also a model of creativity.

Thus, the reflective—creative paradigm of consciousness makes it possible to comprehensively understand the essence and social significance of this unique phenomenon, which plays a major role in the life of man and humanity.

SELF-CONSCIOUSNESS AND PERSONALITY AS A SUBJECT OF CREATIVITY

Another characteristic feature of a purely human form of reflection of reality is that it is not only consciousness, but at the same time self-consciousness. This is a person's awareness of his own "I" in its correlation with the world [4, pp. 129–169]. In this aspect of reflection, it is understandable and quite natural to emphasize its subjective side.

Sometimes the emphasis on the subjectivity of consciousness is expressed by researchers in a rather peculiar way: "Consciousness is a part of the psyche, because not only conscious, but also subconscious and unconscious processes take place in it. Such mental phenomena and actions of a person that pass through his mind and will, are mediated by them, which, therefore, are performed *with knowledge* what he does, thinks or feels are conscious" [10, p. 38]. In a footnote on the same page, the author emphasizes that similar linguistic forms occur in English, French and German (consciousness, ta conscience, das Bewußtsein). The essence of the matter, however, lies elsewhere, in the correlation of consciousness with the subject of consciousness (his "I"), that is, ultimately with consciousness itself as such: "Self-consciousness is consciousness aimed at itself: it is consciousness that makes consciousness its object, an object" [10, p. 109]. In this case, as we see, the inevitability of self-reflection becomes clear.

The analysis of self-awareness requires an appeal to such important concepts as the human "I" and human memory. With each of them, in turn, many other concepts of philosophy, science, social practice are connected with different threads of meaning, behind which are the corresponding phenomena of reality.

The concept of our "I" seems simple, almost self-evident only at first glance. In fact, it is complex and diverse, since it accompanies various periods of a person's life (and it can be long and difficult, with ambiguous situations and circumstances, with a change in essential characteristics to which, for example, age, health status, social status, etc.). Applied to any specific individual "the human "I" changes along with the changing conditions of his life. Nevertheless, in the developing self-consciousness there is some kind of common, invariant foundation, which, like a thread, stretches through our entire conscious life, keeping our personality, our "I" as a whole, relatively stable. Without this foundation, our "I" would disintegrate into separate, torn acts of consciousness" [4, p. 135].

The internally contradictory unity of change and preservation is the essential dominant of the continuous development of this phenomenon. The variability of "I" at different stages of the life of a particular member of society and in different circumstances and the invariance of its substantive core suggest the idea of studying the influence of these factors in the general line of research into the problem of intellectual cre-

ativity, as an example, when it comes to the life of a prominent scientist, original artist, or a talented inventor, designer or politician.

The originality of our "I" is inextricably linked with all the inner wealth of human mental activity. "I" is impossible outside of specific sensations, thoughts, feelings and motives, attitudes and value orientations. However, sensations, thoughts and feelings are constantly changing, passing from one qualitative determination to another. They can be programmed, for example, when an actor is reincarnated. If "I" were reduced to these separate acts of consciousness, then it would change along with them, and there would be no unity in the whole variety of constantly changing states" [4, p. 135]. This is the special meaning of the constant invariant (as the basis of the personality), that it makes possible a kind of constant, as a resultant of the whole variety of constantly changing components of the psyche.

Memory plays an irreplaceable role in personality formation. It also maintains the stability of a person's attitude to himself in different periods of his life, ensures the mutual balance of various factors of mental activity in general. "The basis of the fact that the "I" throughout a person's life remains relatively stable and can resist alien influence, is memory, the ability of the brain to capture, store, and reproduce information ... According to one psychologist, between our "I" today and our "I" yesterday lies a night filled with sleep, the triumph of the unconscious, where the usual connection of thoughts and feelings is cut off. There would be no continuity between these "I" forms if a bridge called memory was not thrown over these black gaps" [4, pp. 135–136].

However, along with this purely personal context, memory, of course, is extremely important also in that it gives a person the opportunity to master the entire wealth of knowledge about reality, about the external world. Creative processes of any kind arise only on the basis of such knowledge, when a person realizes himself precisely as a creator. However, even in this hypothesis of it, one must not forget about the personal content of the subject of creativity, about what lies in the foundation of any type of his activity.

The neurophysiological mechanisms of the formation and functioning of human memory create an amazing in their integrity ensemble of unity of short-term (operational) and long-term, mechanical and logically meaningful, arbitrary and involuntary, individual, and collective (including hereditary and generic) forms of memory [11]. Science has done much to study how various factors affect memory, for example, a person's age, illness, lifestyle, nature of work, etc.

In the study of memory, like other mental phenomena, analysis of the structure and functions of the human brain is of particular importance. As well, in recent decades, scientists from different countries,

naturally, continue to pay great attention to both the study of the brain itself and its connections with creativity, with the development of the creative abilities of the individual, as well as special heuristic technologies and techniques [12–15]. This problem, without exaggeration, is constantly at the forefront of science, already because it directly relates to the innermost secrets of nature, deeply exciting a person and at the same time having a serious practical meaning.

Without fail, relying on the memory of the past and present, any person in the process of life, at the same time, in his thoughts and dreams, is constantly striving into the future. It is in this sense that one should understand as the position that a person always lives simultaneously in three temporal dimensions, past, present, and future. This is also a characteristic feature of our self-consciousness. It costs us nothing mentally to constantly transfer from one dimension to another, moreover, changing times in any sequence.

Thus, “the plasticity and variability of our “I” is manifested primarily in its functional, role-based transformation: at work as a leader, a person is different than, for example, in the role of a father in relation to his daughter ... However, despite the amazing plasticity of the human “I,” it ... possesses internal composure, integrity, and relative stability. Throughout our life, through all reincarnations and states, we carry a stable core of our “I,” conditioned by the unity of the bodily organization, in particular by the nervous system, and by some solid frame of character, temperament, manner of feeling, thinking and acting. Beliefs and principles are the most stable backbone of the “I,” although there are considerable individual variations in this respect” [4, p. 136]. Such stability of the personality helps to maintain internal mental balance, which is always very important in creative work.

Creativity is organically linked with personality and it is not limited to a complex of purely mental phenomena. Personality is usually understood as a stable system of psychologically and socially significant traits that characterize the individual as a member of society and determine his social essence [16]. The personality of the subject of creativity is interesting precisely because it is an integral alloy of different aspects of his life and properties, among which the dominant and guiding aspect is the heuristic nature of human consciousness, paving the way for understanding his social role of the creator.

Meanwhile, adequate personal characteristics of any particular member of society (one or another social community) are completely impossible without referring to the peculiarities of his psyche. “A man is person primarily by his socio-psychological characteristics: intelligence, willpower, observation, motivational sphere, social status and related attitudes, social functions, value orientations, and the nature of his worldview. In other words, the concept of personality expresses the *sociopsychological essence of a person*”

[4, p. 250]. Any subject of creativity (be it a writer, musician, scientist, inventor, or representative of another field of creative activity), along with the appropriate giftedness, must have outstanding character traits in order to achieve recognition among colleagues in the “shop” and noticeable success in society.

Like all complex phenomena of reality, a person’s personality certainly has its own structure, and it also reflects the immanent unity of the psychological and social aspects. “... The elements of the personality structure are, in essence, all the basic mental processes, formations and properties. Personality is an ensemble of socio-psychological formations, properties, and functions that are socially and historically conditioned and peculiar only to a person. It is a harmonious whole in which all parts are mutually coordinated. Its structure must be divided into elements in which the life of the whole beats. Such living elements of the personality structure are, for example, cognitive processes, consciousness and self-awareness, emotions and volitional qualities, the sphere of motivation and character. Character and will are closely interconnected: a person with a strong will also has a strong character. The structure of consciousness and activity forms the structure of the personality” [4, p. 267]. In everything that the subject of creativity is professionally engaged in, one way or another, to a greater or lesser extent, the structure of his personality is reflected.

Thus, a person’s consciousness, inseparably united with his self-consciousness, constantly increases his cognitive-heuristic, as well as psycho-emotional potentials and, thus, general social capabilities. Therefore, the subject of creativity always appears before us as a person who is in the process of continuous internal self-enrichment.

As we can see, the problem of consciousness and self-awareness (with all its possible ramifications) is quite capable of acting as a methodological basis for understanding the creative process. In this respect, the study of creativity (as a phenomenon of great social significance) rests on a solid philosophical foundation. However, the role of philosophy here is not self-sufficient: it is well known that it has long and actively interacted with other areas of knowledge. In this case, the contribution of psychology, sociology, cultural studies, physiology of higher nervous activity, cybernetics, computer science, and heuristics should be especially noted.

For the future, the consciousness and self-consciousness of the individual, undoubtedly, remain the cornerstones in the foundation of the entire ideological and conceptual wealth of the process of studying all kinds of models of human creativity.

THE ROLE OF ART IN THE HISTORY OF CREATIVITY

The study of the development of mankind and its culture leads to the conclusion that historically, the first manifestation of creativity was art. Among the most ancient of its types are graphics, painting, and sculpture. In the Stadel Cave in Germany, a figurine of a creature with a human body and a lion's head carved out of ivory was discovered; it is 32000 years old. It is "one of the first unquestionable signs of the existence of art and, probably, religion, as well as the ability of human consciousness to imagine things that really do not exist" [17, p. 37]. There are also known cave paintings of fantastic creatures of similar style on the walls of the caves of Lascaux and Altamira, where elements of reality are also combined with fantasy.

No one today knows what the "handprints left by hunter-gatherers about 9000 years ago in the "cave of the hands" in Argentina mean. It seems as if these hands of the dead are reaching out to us from the depths of the rock. This is one of the most touching relics of the world of primitive people ..." [17, p. 77]. A photograph of this ancient masterpiece is quite capable of recalling a collage of a modern artist.

The world-renowned Dutch neuroscientist Professor Dick Svaab believes that art emerged during the evolution of the human brain. "Our brains have tripled in size over the past three million years. At the same time, in comparison with other species, a person has formed much more excess brain tissue, which is not necessary for the regulation of body processes. In conjunction with all the more complex metabolic processes in the brain, artistic creativity became possible thanks to this additional brain tissue. About 40000 years ago, the development of the brain reached the level at which it is today. Then, there was a real explosion of creativity, which found its expression in the incredible Lascaux caves in France and Altamira in Spain. The moment when *Homo sapiens* began to produce art, he turned into a modern person" [13, p. 110]. Perhaps not quite modern, but still the leap was quite tangible...

Acquaintance with the lifestyle of the surviving aboriginal tribes in remote corners of the planet makes it very likely the hypothesis that singing, music, and dancing should also be attributed to the oldest forms of art. In particular, these creative forms of primitive culture usually accompanied various ritual ceremonies of early communities.

Since then, art has taken its special place in human life. In this sense, no continent where people live knows any exceptions. While improving the psychoemotional state of a person, raising his mood, works of art are at the same time important because they bring people closer together and contribute to the formation of a common perception of the world.

The history of mankind testifies to the close connection between the nature of artistic creation and the aesthetic views prevailing in society with social condi-

tions and factors. The flourishing of the arts, for example, was largely facilitated by the era of antiquity. It was then that the well-known concepts of artistic creativity and talent appeared in the works of Plato and Aristotle [18, 19]. By analogy with this, each of the subsequent notable stages in the development of world civilization, of course, has its own characteristics in this respect.

Speaking about art, it is imperative to consider that human consciousness is always inextricably linked with the emotional principle, and it literally permeates all works of artistic creation. "A person experiences emotional storms, passions that shake his body, mobilize or restrain his spiritual forces. A person always feels something: he loves or hates, admires, or is indignant. His heart beats in suffering or glee.... Emotions are organically included in the structure of consciousness. Humanity could not be content with only rational thinking, even in the field of science, and even more so in artistic consciousness, where such components as emotional comprehension of truth, its versatility, fundamental anti-schematism, the special role of intuition, imagination and hypothesis, especially in the genre of fantasy are essential" [4, p. 109]. In artistic creation, literally every step is palpably filled with the emotional principle of human consciousness.

The originality of art in various periods of civilization is determined by the peculiarities of the visual means of each historical stage. In addition, the general palette of these means is complex and diverse, since it is always determined by the richness of species and genres.

Of particular importance in artistic creation is a visual image that provides a direct perception of a specific object of reality and the creation of an idea about it [20]. In this case, the recipient of a certain work of art enjoys the comparative freedom of his own sensory construction of some features of the object. This is important in itself, because it gives a person who perceives art a feeling of psycho-emotional comfort.

The world around a person is constantly changing, and this alone explains the variability of the art world. Along with this, works of art from different eras differ significantly in their genre-specific and stylistic diversity under the influence of various social conditions and factors. All this together leads to a constant increase in the variety of visual means and techniques.

In this sense, the last centuries stand out especially. A. Moles called this property the *sociodynamics of culture* [21]. Of course, the concept of culture is by no means reducible to art, and in this particular case its problems have been significantly expanded through the use of the achievements of the scientific and technological revolution (primarily the sociocybernetic aspects of culture). Today, as never before, it is important to accentuate all aspects of artistic creation organically associated with the information revolution in society [22–28]. For many years the use of com-

puter technology in the creative act of an artist, architect, composer, cinematographer and television director has become, as they say, commonplace. Many original works of contemporary art owe their birth not only to man, but also to microelectronic technology.

Analyzing the phenomenon of artistic creativity (and even more broadly, creativity in general, as such), it is logical to pay special attention to the problem of the abilities of the person involved in it. The well-known psychologist K.K. Platonov long ago published the solid generalizing work [29] on this topic, in which the main aspects of the problem are systematically considered. In this case, abilities are understood as “a part of the personality structure that, being actualized in a specific type of activity, determines the quality of the latter. The doctrine of abilities, being part of the doctrine of personality, can neither be understood nor considered outside the latter” [29, p. 5]. To help the reader adequately decipher this somewhat formal definition, here is a more specific formula: abilities “represent the totality of those personality traits ... which determines the possibility of successfully mastering the corresponding activity and improving in it” [29, p. 102]. To apply this formulation, for example, to artistic creation, it is necessary to consider the characteristics of this particular type of human activity.

Another concept of the same semantic range as ability is talent. Obviously, it is stronger in the sense that it expresses a higher, very high degree of abilities of a certain orientation. However, apparently, it is still not an extremely high degree, since there is also the concept of genius. It is genius that embodies the utmost possible creativity in every field of activity. Both talent and genius levels of abilities have an innate nature, genetically inherent in the body, organically connected with the peculiarities of the personality psyche.

For artistic creation (however, as well as for other types of creative activity), the state of inspiration is very characteristic and important. It is precisely this that gives the highest results of creativity associated with unexpected insights. “Inspiration is a state of the highest, most intense and productive tension of all the spiritual and physical forces of the master; he works at this time as if against his will; someone invisible, according to Gogol, writes in front of him with a powerful rod. In these happy moments, the artist disconnects from the outside world and concentrates entirely on his work” [18, p. 96]. These are those blessed moments when the muse visits the poets (“... and poetry awakens in me ...”; A.S. Pushkin).

In one way or another, inspiration is familiar to almost everyone who is engaged in creative work. This is a very interesting, unforgettable, and incomparable state. As well, it is especially among people of art that it runs especially brightly.

“In the act of inspiration, the artist is completely in the grip of intuition. He creates without controlling

himself, without correcting, without analyzing the poem or painting he creates. The amendments will begin later ... During inspiration, the personality of the creator splits, as it were, although he himself does not realize this. The artist, forgetting about himself, about the world in which he really exists, creates a new world and new “people”, the heroes of his work. The process of such creation is sometimes accompanied by strange visions and sensations (the “strangeness” of talent, to which Plato first drew attention). Many artists were so reincarnated as their heroes that they began to perceive them as specific people or identified them with their own personality ... Surikov almost physically felt the torment of the archer, who was being led to execution. Flaubert felt on his tongue the taste of arsenic, which poisoned Emma Bovary ... Dante, Hoffmann, Schumann, Maupassant, Dostoevsky, Wagner and other artists had hallucinations. A number of contemporary artists admitted ... that they experienced strange psychological states when it was practically impossible to draw a clear line between vision and reality, reality and unreality” [18, pp. 97–98].

A certain “strangeness” of the talent of a number of contemporary artists (but “strangeness” of a different kind, significantly different from the one just considered) is associated with such special trends in the visual arts as abstractionism, surrealism or formalism (manifested much more widely, also in literature, music, etc.). “Abstract art is a modern invention of humanity. The first abstractions were created about 100 years ago” [13, p. 138]. However, in general, the dynamics of the development of aesthetic tastes and views of society has long significantly expanded the range of the possible manifestations of artistic creativity.

It goes without saying that the direction of the artist’s creative self-realization and his creative manner can fluctuate within very wide limits (and change over the course of his life due to changes in views and tastes, with the general development of the personality). Moreover, this applies to the various circumstances that accompany artistic creation. There are many details of the creative process, where, in principle, there can be no mandatory strict regulation, everyone has the right to solve such issues in their own way. As an example, “the Spanish artist Miro believes that you cannot start work without putting perfect order in your studio. As well, for Picasso, chaos in the workshop is a normal phenomenon, he feels like a fish in water in it, which, by the way, irritates his friend Miro. Or: one poet spends time at his desk from 9 am to 1 pm, another, from 6 am to 11 am. Whose regime is better? A pointless question. Senseless for the theory of creativity ...” [18, pp. 113–114]. The psychology of creativity, obviously, must consider the individual characteristics of each art worker.

At the same time, the statements of some world famous artists and scientists (such as Leonardo da

Vinci, Newton, Edison, and the French painter Degas) that they did not experience a state of inspiration are somewhat discouraging. The renowned sculptor Auguste Rodin, addressing young artists, said: "Don't be impatient. Don't count on inspiration. It does not exist. The only virtues of the artist are wisdom, attentiveness, sincerity, and will. Do your work like honest workers" [18, pp. 114–115]. Undoubtedly, human natural talent alone is not enough to create masterpieces of art. The importance in the life of a talented artist of constant and hard work (in the words of Chekhov, "hard labor") is understandable, but as far as inspiration is concerned ... in the field of artistic creation, by no means everything is unambiguous.

The development of art continues and people of the future will not be able to live without it, as it was in the past, as it is today. Creativity in this most important sphere of social life remains an extremely necessary type of human creative activity.

THE HEURISTIC POSSIBILITIES OF INFORMATION

The study of the motives, nature, and mechanisms of creativity began a very long time ago, in fact, from the time of antiquity. However, with the beginning of the information revolution, it acquired, as they say in sports, a new, second wind. Of fundamental importance in this regard was the formation of an information approach to the cognition of reality [27]. It was here that the opportunity arose to study creativity as a special phenomenon in the world of other phenomena of an informational nature.

Literally the whole life of a person, from birth to death, is inextricably linked with information. Thus, it will not be an exaggeration to think that he is, in the full sense of the word, an informational being (just like in other aspects, material, living, biopsychosocial). As well, any creative act (of any kind) is by no means least important for a person in the fact that information in it always generates some new information.

Information acts as a kind of self-generating (and therefore self-growing in the process of human use) phenomenon. To this, by the way, the thought of A.D. Ursul applies (which arose, however, in a different semantic context, when it came to the resources for the development of society): "In conditions when practically all material-energy resources are limited and rapidly decrease, information acts as a factor, in principle, unlimited, not showing a tendency to decline ... Information is probably the only resource that tends to increase the efficiency of use in economic and social aspects" [30, pp. 86–87].

Thus, information is a phenomenon that grows itself in the process of its use by a person (since his consciousness inevitably produces new, additional information on an initial basis). In particular, any act of creativity is socially valuable for this. In a personal

perspective, the importance of this new and additional information for a particular person is ensured and enhanced by the fact that this is a reaction of his consciousness (to the previously received information, perceived through the object of creativity), an echo, as they say, of some strings of his soul.

Since social information is a very complex, hierarchical, multi-level system of various types and means that serves society in a comprehensive manner [24], it is natural that different types of information (scientific, technical, and artistic) are involved (to one degree or another) in different acts of creativity, that is, political, etc.

When it comes to such a mega-object as society as a whole, many researchers note objective difficulties in the way of receiving and processing information. These are caused by the fact that human subjectivism in the awareness and assessment of information phenomena is inevitably added to the species diversity of information. However, how the subject himself evaluates his work is one thing, and how society treats this act and its result is another thing.

The structure of any information process necessarily presupposes the presence of a source and a receiver of information; without them, the process of generating an information signal (information as such, with its special content) is completely impossible. Similarly, every act of creativity has two obligatory components, these are the subject and the object. Only their interaction ensures the flow of creative activity. However, being both necessary components of the creative act, they are at the same time clearly unequal in their role: for the subject of creativity it is active and defining, for the object it is passive and completely subordinate. If the subject of creative activity can only be a thinking and acting person (personality), then the object can have a very different content. The theory of creativity allows one to study each of these most important phenomena from certain worldview and scientific positions, investing in it an adequate information content.

Often, the circle of subjects of creativity is seen rather narrowly, it is limited to the framework of a few elite professions. In contrast, A. Mohl believes that "creativity ... is not a rare and amazing privilege of outstanding personalities, for most people tend to create new things in their daily lives. Differences between different people in this regard are only quantitative in nature, they determine the greater or lesser socially significant value of what a particular person creates, as well as how often he engages in creative activity, which in turn depends on his lifestyle ... Creative ability is a special ability to rebuild elements in the field of consciousness in an original way so that this restructuring would provide the ability to perform certain operations in the field of phenomena" [21, p. 108]. In the cases where ideas are most valuable to society, Moles continues, "the possibilities of creative activity presuppose the possession of the initial material (necessary

knowledge), as a result of which such creativity is available only to specialists, a scientist, poet, artist, writer and other creative workers who, with the help of their imagination, create images with universal value" [21, p. 108]. As one can see "elements in the field of consciousness," knowledge, imagination, and images are all informational phenomena.

Objects of creativity are, in general, always different ideas, images, models, the study of which is already interesting because it allows one, first of all, to see the diversity of their natural substance (in other words, the material from which they are created). For art, this is, for example, the language and speech of a person (literature and some pop genres), artificially created sounds (music), canvas, paper, paints and pencils, wood, clay, stone, plaster, metal, etc. (visual arts), and human body movements (choreography and ballet). For science, all sorts of ideal phenomena of cognition (which will be discussed further, in the last section of the article).

Along with the peculiarities of the problem of substance, the study of objects of creativity makes it possible to reveal the nature of the tools used by the creator (at least in some cases). Traditionally, these are, for example, brushes, a palette, a palette knife and an artist's easel, a sculptor's chisel and hammer, all the variety of musical instruments, in science, a microscope, a telescope, etc.

In the process of the information revolution, the emergence of fundamentally new types of creative tools gave rise to the development of microelectronic computer devices. These works were developed for a long time under the banner of cybernetics [31, 32]; the term "informatics" in its broad meaning came into use a little later.

First of all, the progress of cybernetics influenced, of course, the development of the logic of thinking of scientists and this meant serious shifts in the methodology of scientific creativity, in science as a system of knowledge of the world. Along with the concept of management (the "title" for this new scientific discipline), the concept of information has been put in one of the most prominent places in science and social practice [33, 34]. Moreover, very soon it turned into a general scientific category, thereby laying the foundation (of course, together with other concepts of similar importance) to a qualitatively new class of scientific concepts [35].

For the theory of creativity, the concept of information turned out to be extremely important, first of all, because it obviously substantively brings together various types of human creative activities according to their main result, the receipt of fundamentally new information of a certain type (economic, political, technical, etc.). This type of information does not matter. It is the heuristic orientation of such information that turned out to be the defining characteristic of any act of creativity. In other words, the information

approach to the cognition of reality, which is being formed under the conditions of the scientific and technological revolution, has highlighted a new, information, criterion as the basis of a semantic grouping of externally very different (especially with a superficial interpretation) manifestations of people's social lives.

The theory of cybernetics gave a powerful impetus to the development process, first of all, of scientific creativity itself [34], which contributed to the already noted qualitative changes and tangible shifts in the methodology of science. According to the metaphor of B.V. Biryukov, science of the 19th century (and we add, to a large extent, also the first half of the 20th century.) "used four basic "colors" in its palette. The concepts of matter, motion, space and time served as these "colors." Cybernetics showed that the palette lacks one more "paint": information. Only the addition of the concept of information to the four categories mentioned above makes it possible to build an integral picture of reality" [33, p. 22]. Thanks to this, scientists of different specialties and branches of knowledge received a new tool with great heuristic power for their work. The rapid spread of the achievements and basic ideas of cybernetics across the entire field of scientific knowledge was not a kind of fashion, it was associated with real opportunities to ensure, on this basis, high productivity in various areas of scientific research and genuine creativity of the results of new research. The adequacy of this conclusion has long been tested and is confirmed by time.

Along with the general theory of cybernetics, its technical, purely applied aspect was rapidly developing and it was on this path that the triumphant successes of microelectronic computer technology were achieved [36–38]. Many specific examples of the use of computers in various fields of knowledge can be cited, starting with those that are considered models of accuracy: mathematics and mathematical logic. Let us name just one such example: machine derivation of theorems [34, pp. 315–333]. The complexity of this work for a scientist, a mathematician, or a logician, can be fully assessed only considering an issue that was cited in his time by V.M. Glushkov: "A mathematician proved one theorem using 280 pages. Few have read this work to the end; however, those who have read it could not say with certainty that there are no errors and that the theorem was indeed proved" [36, p. 452]. It is clear that the use of computer technology in such cases (where there are no fundamental scientific counterarguments associated, for example, with the openness of the field of research) will certainly make it possible to introduce a person's work into an acceptable and reasonable framework. However, this is an exotic example, so to speak, while cybernetic modeling of specific objects and processes in various fields of science is a task on a mass scale [34, pp. 237–253].

Technical cybernetics, informatics and, of course, heuristics have long been conducting a creative search

in the field of *artificial intelligence*. The meaning of this work, as scientists have repeatedly stressed, is by no means to replace a person, as a subject of thinking and creativity, with a technical automaton. The goal is completely different: to create an effective and reliable assistant for a person in this area. As well, much has already been achieved on this path.

One notable feature of the second half of the 20th century is the continuously expanding use of information technology in artistic creation. Electronic synthesizers of image, color and sound have become widespread, which opened up new prospects for creativity in architecture, design, cinema, music, theater, television, video equipment, on stage, when creating grandiose color and musical performances at stadiums, parades, etc. [34, 38]. Such concepts as computer graphics, electronic music, computer design, and computer layout have reliably entered into practice.

At the intersection of art and science are such creative professions as literary critic and art critic. V.M. Glushkov noted that the rationalization of their work with the help of computer technology is very promising. At the same time, such properties of a computer as the tremendous speed of reading texts and practically error-free memory are used, which allows one to immediately remember the peculiarities of the style of each author. "In this way, the idea that the Iliad and Odyssey were written by the same author, Homer was confirmed and was convincing" [36, p. 458]. In this sense, literary creativity is no exception. In different genres of painting, graphics, cinema, etc. computer devices are successfully used for the purpose of artistic examination and the search for new heuristic means.

Information technology (which is more and more digital in recent years) has long since made its way into the field of sports, to stadiums and gyms. Here, the roles and functions of computer devices are quite diverse, in athletics and weightlifting, gymnastics (both sports and artistic), acrobatics, swimming, fencing, in game sports, etc. Chess creativity should be noted: in the world of sports it clearly represents intelligence. Chess computers have long been a special kind of information technology, grandmasters of all countries systematically use them in their preparation for the most important competitions.

Thus, the development of any kind of human creative activity clearly demonstrates the birth of new information in the process of using the type that was previously available. Information is the foundation of creativity as a special property of activity that accompanies a person's entire life. As well, among all the tools of creativity, the role of information technology stands out more and more clearly. Cybernetics paved the way for it in its time, then passed the baton to informatics [25, 26, 28]. The progress of information technology is a necessary condition for the further development of the mechanisms of creativity.

It is safe to assume that the heuristic potential of the entire wealth of social information is capable of covering all areas of society and all professions that exist in it. In other words, the future does not inspire any fear in this respect.

SCIENTIFIC CREATIVITY: INFORMATION AND INTUITION

The progress of science has long been one of the determining factors in the development of society. The scientific and technological revolution has greatly strengthened this trend. Under the conditions of the scientific and technological revolution, the work of research workers of institutes and laboratories, which was once the work of a few people, has turned into one of the varieties of mass labor. As well, it remains, of course, creative work.

The work of a scientist is rooted in the common human knowledge of the world, one of the main types of human activity, starting from ancient times [39, pp. 58–63]. All the principles and laws of cognitive activity, no doubt, have long been working in the field of scientific work [40, 41]. At the same time, another thing is also clear: the creative work of scientists, undoubtedly, belongs to those professions that require special abilities from a person. First of all, of course, solid knowledge is needed in the chosen field of science, and not only in it: the deepening of the integration of modern science requires sufficient erudition in other fields from the researcher, and most importantly, the ability to perform scientific work, the talent of a researcher.

The image of a certain object occupies a special place in the structure of scientific knowledge. The creative process very often begins with him. "The ordinary idea of an image is associated, as a rule, with its sensory visualization; however, in science the concept of an image has a broader meaning, also covering rational forms of reflection, including theory. In the general sociological sense, an image is understood as any discrete (separate) element of knowledge that carries meaningful information about a certain class of objects" [20, p. 15]. Based on this, ideal cognitive images can be of two types: sensually visual and rational (conceptual). The sphere of scientific cognition of reality is characterized by the ability of the researcher to mobilize certain theoretical tools to fill the used image, which adequately reveal the nature and semantics of the cognized object. One of the important trends in the development of science is that the degree of inaccessibility of acquired knowledge is constantly increasing.

Among the tools of scientific cognition that have been tested by experience and have proven their fruitfulness we note the originality of a thought experiment: it necessarily requires the creative imagination of a scientist. A real experiment always means a change

in the natural course of processes; in a mental experiment, this issue is replaced by theoretical reasoning; however, it is included in the experimental scheme (as a means of the empirical level of research). One of the most famous examples of this is A. Einstein's thought experiment with an observer inside an elevator freely falling towards the planet [20, p. 255]. This is how the general theory of relativity was formed. It would seem to be a scientist's "free fantasy"; however, sometimes it can eventually lead to a great discovery.

The process of self-knowledge of science, which noticeably deepens with time, is not least determined by the achievements of the psychology of scientific creativity [42, 43]. This discipline has long been one of the important components of general science of science. Psychology, along with philosophy, of course, has a special place in the study of any cognitive phenomena.

Researchers of any kind of creativity always emphasize the heuristic role of intuition. This is an instant reaction of consciousness, a guess, giving rise to the ability to comprehend the truth without its logical evidence (discursive) or justification. The mental activity of a person often generates intuitive impulses of cognition, which, in particular, have a noticeable scientific significance [44]. The study of known cases of scientific intuition convinces us that it is usually based on the preliminary accumulation of large amounts of relevant information. It is not for nothing that a half-joking aphorism is circulating among scientists: "Information is the mother of intuition." In fact, there is serious meaning behind it. According to legend, Archimedes discovered his law while sitting in the bathtub. Mendeleev saw the periodic table of elements in a dream, which has since been named after him. However, something else is undoubtedly true: these outstanding scientists were struggling with the corresponding problems for a considerable time. As they say, intuition does not visit the lazy.

From the standpoint of the psychology of scientific creativity, behind the phenomenon of intuition there is a moment of sudden insight when the accumulated thesaurus of information unexpectedly (to the researcher himself) turns into a new quality, generates information that is new in both its form and content (this is the main issue!). The fact that at the same time there is no direct logical proof method of deriving the truth is not so important. First of all, the very fact of the appearance of this new information is important. A discursive way of confirming it in science may be discovered later.

It has been known for a relatively long time that one can divide researchers by the nature of their work into two main types, theorists and experimenters. "Earlier in the history of science, there were many outstanding scientists who united both theorist and the experimenter in one person (Lomonosov, Lavoisier, Faraday, Helmholtz, Maxwell, Kelvin, Sechenov, etc.).

There are also many scientists in modern science who have played an outstanding role in the development of both experimental and theoretical research (Pavlov, Planck, Rutherford, etc.). However, more and more often, such a combination becomes difficult. Theoretical research forms such a "groundwork," which largely determines empirical study and searches for effective methods of practical application of scientific knowledge" [40, p. 248]. It is clear that the creative impulses and mechanisms, as well as the sources and forms of information used in these two types of scientific work will be different.

Outwardly, inventive work is close to experimental work; however, this special type of scientific and technical creativity, of course, is impossible without theoretical knowledge and searching by the scientist. However, each specific case of inventive activity requires an individual approach. A very illustrative example in this sense is the comparison of the creative attitudes of two outstanding scientists and inventors in the field of electrical engineering, N. Tesla and T.A. Edison [45, pp. 52–53; 46, pp. 8–9]. Unlike Tesla (who was primarily a theoretician), Edison said of himself: "I'm just a professional inventor. All my research and experiments were carried out solely in order to find something of practical value" [45, p. 53].

Even A. Einstein, who is world famous as a theoretical physicist, was very actively involved in experimental and inventive activities; he received more than 50 patents (in different countries). Among his inventions, a prominent place is occupied by an absorption refrigerator, a magnetostrictive loudspeaker, an automatic camera, an induction suspension, and a meter of very low voltages; as we can see these are devices for purely practical purposes that are very far from the theory of relativity. "What is even more surprising, Einstein holds a patent for the design of a blouse" [47, p. 8]. Thus, the great theoretical physicist had a very respectful attitude to practice, to the idea of the practical value of his creative achievements.

Today, it is even strange to imagine what could have been different. Meanwhile, there was, after all, the opposite position, science appeared to some scientists as "pure knowledge," without any interest in the results. This was recalled with considerable irony by the English writer and scientist Ch. Snow: "Most of all, we were proud of the fact that our scientific activity under no conceivable circumstances can have practical meaning. The louder it was possible to proclaim it, the more majestically we held on" [48, pp. 42–43]. The real process of development of society, of course, leads to the elimination of such views from social life: any kind of human creativity is intended to serve his interests in a certain way.

The life and work of A. Einstein are instructive in another respect. The versatility of his creative abilities was not limited to the field of scientific theory (especially physics and mathematics), experimentation and

technical invention. This versatility had outputs in the field of art. "Love of music was in the blood of the great genius. His mother was a pianist, and he was fond of playing the violin" [47, p. 42]. He started playing the violin at the age of 6 and this passion accompanied him all his life. As well, the above-mentioned patent for the design of a blouse is the result of a creative search at the intersection of applied art (which is any design option) with technology. Much is also evidenced by his words that Dostoevsky gives him more of than any scientist, and more than Gauss. The heuristic interaction of information and creative impulses coming from artistic culture, science and technology can be seen in the life of the great author of the theory of relativity, an outstanding physicist of the 20th century.

The names of Einstein, Tesla, and Edison are directly related to another important methodological problem of scientific and technical creativity, that is, to the relationship between fundamental and applied research. As a first approximation, the core of their comparison looks something like this: "Fundamental research is associated with the study of new phenomena, effects, and processes, as well as with the discovery of new laws that govern these phenomena. Applied research uses the results of fundamental research in the interests of society" [49, p. 40]. These types of research are characterized by a difference not only in their results, but also in the information used in them. This problem has acquired particular importance in the context of the deepening scientific and technological revolution [50].

Considerable attention is paid to the issues of scientific and engineering creativity in the context of the tasks of forecasting scientific and technological progress. The prospects for the development of society now significantly depend on it. In this regard, it is necessary to emphasize the methodological role of forecasting as a special branch of research that is extremely necessary in the conditions of the scientific and technological revolution. The basis of this new direction of the work of scientists and specialists is the study of the characteristics of predictive information, the mechanisms of its receipt, and processing methods. It is quite clear that the development of this type of creative work would be simply impossible without the means, methods, and technologies of modern informatics.

Science fiction has long been an absolutely original form of creativity at the intersection of science and art. Among the founders of this genre, one can recall Jules Verne, but we would especially like to highlight Herbert Wells, a writer who relied on the latest scientific concepts of his time in his works. His best novels (*The Time Machine*, *The Island of Dr. Moreau*, *The Invisible Man*, etc.) are still read with great interest [51]. Notable contributions to the development of science fiction were made by A.N. Tolstoy (*Aelita*, *The Hyperboloid of Engineer Garin*), A.R. Belyaev (*The Head of Professor*

Dowell, *Amphibian Man*, and *The Star of the CEC*) and A.P. Kazantsev (*The Burning Island*, and *Grandchildren of Mars*). Science fiction writers have foreseen dozens of scientific discoveries and achievements of the future. Over time, on the basis of their work in fiction and journalism, qualitatively new variations arose, fantasy (fiction, but not scientific) and philosophical dystopia, which can be exemplified by the novels *1984* by J. Orwell's and *Fahrenheit 451* by R. Bradbury.

Science fiction as a special direction of creativity in culture is extremely important because it attracts the attention of young generations, first of all, to the topical problems of science, technology, and social practice, for those who make up the future of society.

In conclusion of this section, let us dwell on the role of scientific creativity in solving problems of paramount importance and in those studies that are directly related to the global problems of humankind and the achievement of the characteristics of sustainable development [30, 52–55]. There is no doubt that it is precisely this category of goals of modern science that has the greatest inherent complexity and at the same time urgency: these problems must be solved immediately, today, tomorrow it will be too late.

As A. Peccei emphasized, back in the mid 1970s humanity stands "before a dramatic alternative, either to create a truly global society based on solidarity and justice, diversity, and unity, interdependence and self-reliance, or everyone will find themselves (at best) in the face of the collapse of the human system, which will be accompanied first by regional, and then by global catastrophes" [52, p. 174]. More than 40 years have passed since then, but in all this time the world community has only been stuck in solving problems that are, without exaggeration, vital.

Unfortunately, even today, not everyone on the planet (even in the ruling circles of different countries) really understands that "global problems require global answers" [53, p. 146]. The time has long come when the planetary civilization should be united in fulfilling the "Agenda for the 21st Century," which are plans outlined by the world's scientists. In many cases, selfish interests prevail over the universal human objectives of the sustainable development strategy. Even in the current pandemic, it is not possible to establish the necessary close cooperation of all countries in the fight against an obvious threat.

The creativity of scientists and specialists in order to implement the concept of sustainable development has the peculiarity that most often it should be realized in transdisciplinary research and projects [54]; in the same work, the strengthening of integrative tendencies in science of the scientific and technological revolution era is reflected with full force. The most important role in this variant of scientific and technical work is played by the heuristic fertilization of information of one kind by other varieties of this phenomenon. An illustrative example of such a process is the develop-

ment of the problems of the World Environmental Constitution for its subsequent introduction into social practice [55]. The greening of society remains the most important aspect of the entire front of work to promote world civilization to sustainable development.

Another methodologically important section of this area of scientific work is the closest interaction between theorists and experimenters, everyone who conducts fundamental and applied research. As an example, in the fight against the global danger of coronavirus infection, the applied aspect of the scientific search of physicians today is associated with the urgent need to develop effective methods for diagnosing and treating this disease; a vaccine against it is also needed. At the same time, one cannot do this without fundamental research in virology and epidemiology, aimed at a deep study of the nature of viral diseases in general: after all, in the future, obviously, other types of viruses will appear, no less dangerous than COVID-19. Mutations are also known in the world of viruses and their nature and consequences must also be studied at a fundamental level. Sustainable development issues, of course, include many such questions.

On the whole, work in science undoubtedly remains the most important area for the application of human creative forces. As well, objectively, a full measure of social responsibility for its results is required.

CONCLUSIONS

All types of creativity are one in their essence. This creativity is the fundamental ability to create something completely new, which was absent before, which is one of the most characteristic features of human life and activity. Without creativity, the formation, functioning, and development of world civilization on our planet would be impossible.

Consciousness and self-awareness of a person are the main factors of creative activity. Understanding them requires an appeal to such fundamental philosophical categories as interaction and reflection. According to some researchers, the theory of reflection allegedly denies the activity of the subject, in connection with which the recognition of the principle of reflection in human activity is allegedly incompatible with creativity. However, this is not the case. The fact is that not just a mechanical (mirror) reflection of any thing is inherent in a person, but an active reflection of reality; it is on this basis that creativity is born.

The most important attribute of a person as a biopsychosocial being is the formation of a personality; only she can become a subject of creative activity. Memory plays an irreplaceable role in the constitution of personality.

As the history of civilization shows, art and science belong to the main spheres of social life, in which the processes of creativity are manifested. All works of artistic culture literally downgrade the emotional principle, without which human consciousness never

exists. On the other hand, the work of a scientist is rooted in universal human knowledge of the world as the personification of the logical principle.

Since the beginning of the information revolution, the study of creativity is increasingly starting from the fact that any information in its development generates new information: after all, thinking is information modeling of reality (V.M. Glushkov). Thus, creativity began to be studied as an information phenomenon by its nature. From this point of view, for example, the substance of the objects of creativity in its various varieties and the role of various instruments, as well as motives, goals, results of creative activity, etc., can be considered. With the progress of cybernetics, computer science, and heuristics (as the science of creative thinking) computer devices and technologies have become a universal type of creativity tools. In essence, this area is information technology. In the era of the scientific and technological revolution, it plays the most important role in the life of the whole society.

The particular interest to researchers of creativity continues to be attracted by questions about the relationship between information and intuition, about the meanings of ability, talent, hard work, and inspiration. The uniqueness of this phenomenon (as an organic alloy of very different properties) explains the desire of scientists from different branches of knowledge to learn more and more about creativity.

CONFLICT OF INTEREST

The authors declare that they have no conflicts of interest.

REFERENCES

1. Gaidenko, P.P., Spirkin, A.G., and Yaroshevskii, M.G., Creativity, in *Filosofskii entsiklopedicheskii slovar'* (Philosophical Encyclopedic Dictionary), Moscow: Sov. Entsikl., 1983, pp. 670–671.
2. Pushkin, V.N., *Evrastika - nauka o tvorchestvom myshlenii* (Heuristics: Science of Creative Thinking), Moscow: Politizdat, 1967.
3. Pospelov, D.A. and Pushkin, V.N., *Myshlenie i avtomaty* (Thinking and Automats), Moscow: Sov. Radio, 1972.
4. Spirkin, A.G., *Soznanie i samosoznanie* (Consciousness and Self-Awareness), Moscow: Politizdat, 1972.
5. Ursul, A.D., *Otrazhenie i informatsiya* (Reflection and Information), Moscow: Mysl', 1973.
6. Korshunov, A.M., *Teoriya otrazheniya i tvorchestvo* (Reflection Theory and Creativity), Moscow: Politizdat, 1971.
7. Spirkin, A.G. and Yaroshevskii, M.G., Consciousness, in *Filosofskii entsiklopedicheskii slovar'* (Philosophical Encyclopedic Dictionary), Moscow: Sov. Entsikl., 1983.
8. Glushkov, V.M., Thinking and cybernetics, *Vopr. Filos.*, 1963, no. 1, pp. 36–49.
9. Glushkov, V.M., Epistemological nature of information modeling, *Vopr. Filos.*, 1963, no. 10, pp. 13–18.
10. Tugarinov, V.P., *Filosofiya soznaniya* (Philosophy of Consciousness), Moscow: Mysl', 1971.

11. Vein, A.M. and Kamenetskaya, B.I., *Pamyat' cheloveka* (Human Memory), Moscow: Nauka, 1973.
12. Swaab, D., *Wir Sind Unser Gehirn: Wie Wir Denken, Leiden und Lieben*, Munchen: Droemer Verlag, 2011.
13. Swaab, D., *Unser Kreatives Gehirn: Wie Wir Leben, Lernen und Arbeiten*, Munchen: Droemer, 2017.
14. Michalko, M., *Thinkertoys: A Handbook of Creative Thinking Techniques*, New York: Ten Speed Press, 2006.
15. Kaku, M., *The Future of the Mind: The Scientific Quest to Understand, Enhance and Empower the Mind*, Doubleday, 2014.
16. Kon, I.S., Personality, in *Filosofskii entsiklopedicheski slovar'* (Philosophical Encyclopedic Dictionary), Moscow: Sov. Entsikl., 1983.
17. Harari, Y.N., *Sapiens. A Brief History of Humankind*, London, Harvill Secker, 2014.
18. Gromov, E.S., *Khudozhestvennoe tvorchestvo (Opyt esteticheskoi kharakteristiki nekotorykh problem)* (Artistic Creativity (Experience of Aesthetic Characterization of Some Problems)), Moscow: Politizdat, 1970.
19. Zis', A.Ya., *Iskusstvo i estetika* (Art and Aesthetics), Moscow: Iskusstvo, 1975.
20. Slavin, A.V., *Naglyadnyi obraz v strukture poznaniya* (Visual Images in the Structure of Cognition), Moscow: Politizdat, 1971.
21. Moles, A.A., *Sociodynamique de la Culture*, Den Haag: Mouton, 1962.
22. Rakitov, A.I., *Filosofiya komp'yuternoi revolyutsii* (Philosophy of the Computer Revolution), Moscow: Politizdat, 1991.
23. Ursul, A.D., *Informatizatsiya obshchestva. Vvedenie v sotsial'nuyu informatiku* (Informatization of Society. Introduction to Social Informatics), Moscow: AON, 1990.
24. Tsyrdya, F.N., *Sotsial'naya informatsiya. Filosofskii ocherk* (Social Information. Philosophical Essay), Kishinev: Shtiintsa, 1978.
25. Arskii, Yu.M., Gilyarevskii, R.S., Turov, I.S., and Chernyi, A.I., *Infosfera: Informatsionnye struktury, sistemy i protsessy v nauke i obshchestve* (Infosphere: Information Structures, Systems, and Processes in Science and Society), Moscow: VINITI, 1996.
26. *Informatika kak nauka ob informatsii (Informatics as a Science on Information)*, Gilyarevskii, R.S., Eds., Moscow: FAIR-PRESS, 2006.
27. Semenyuk, E.P., *Informatsionnyi podkhod k poznaniyu deistvitel'nosti* (Informational Approach to Cognition of Reality), Kiev: Naukova Dumka, 1988.
28. Semenyuk, E.P., *Informatika: dostizheniya, perspektivy, vozmozhnosti* (Informatics: Achievements, Prospects, and Opportunities), Moscow: Nauka, 1988.
29. Platonov, K.K., *Problemy sposobnosti* (Problems of Abilities), Moscow: Nauka, 1972.
30. Ursul, A.D., *Put' v noosferu (kontseptsiya vyzhivaniya i ustoychivogo razvitiya tsivilizatsii)* (The Path to the Noosphere (The Concept of Survival and Sustainable Development of Civilization)), Moscow: Luch, 1993.
31. Wiener, N., *Cybernetics: Or Control and Communication in the Animal and the Machine*, New York: John Wiley & Sons, 1948.
32. Wiener, N., *The Human Use of Human Beings*, Houghton Mifflin, 1950.
33. Biryukov, B.V., *Kibernetika i metodologiya nauki* (Cybernetics and Methodology of Science), Moscow: Nauka, 1974.
34. *Kibernetika i sovremennoe nauchnoe poznanie* (Cybernetics and Modern Scientific Knowledge), Moscow: Nauka, 1976.
35. Semenyuk, E.P., *Obshchenauchnye kategorii i podkhody k poznaniyu (Filosofskii analiz)* (General Scientific Categories and Approaches to Cognition. (Philosophical Analysis)), Lvov: Vishcha Shkola, 1978.
36. Glushkov, V.M., *Kibernetika. Voprosy teorii i praktiki* (Cybernetics. Problems of Theory and Practice), Moscow: Nauka, 1986.
37. Glushkov, V.M., *Osnovy bezbumazhnoi informatiki* (Fundamentals of Paperless Informatics), Moscow: Nauka, 1982.
38. *Upravlenie, informatsiya, intellekt* (Control, Information, and Intelligence), Berg, A.I., Ed., Moscow: Mysl', 1976.
39. Kagan, M.S., *Chelovecheskaya deyatel'nost' (Opyt sistemnogo analiza)* (Human Activity (Experience in Systems Analysis)), Moscow: Politizdat, 1974.
40. Gerasimov, I.G., *Nauchnoe issledovanie* (Scientific Research), Moscow: Politizdat, 1972.
41. Shvyrev, V.S., *Nauchnoe poznanie kak deyatel'nost'* (Scientific Cognition as Activity), Moscow: Politizdat, 1984.
42. Ponomarev, Ya.A., *Psikhologiya tvorcheskogo myshleniya* (Psychology of Creative Thinking), Moscow: Akad. Pedagog. Nauk RSFSR, 1960.
43. *Problemy nauchnogo tvorchestva v sovremennoi psikhologii* (Problems of Scientific Creativity in Modern Psychology), Moscow: Nauka, 1971.
44. Ponomarev, Ya.A., *Psikhika i intuitsiya* (Mentality and Intuition), Moscow: TID Aris, 2010.
45. *Tainy i zagadki Nikol'y Tesly* (Secrets and Mysteries of Nikola Tesla), Pernat'ev, Yu., Ed., Kharkov: Klub Semeynogo Dosuga, 2019.
46. Semenyuk, E.P., Information aspect of social responsibility for the future of humanity, *Sci. Tech. Inf. Process.*, 2020, vol. 47, no. 1, pp. 1–14.
47. Chaika, V., *Al'bert Eynshteyn* (Albert Einstein), Kiev: Lotos, 2018.
48. Snow, Ch.P., *The Two Cultures and the Scientific Revolution*, Cambridge Univ. Press, 1959.
49. *Filosofskie voprosy tekhnicheskogo znaniya* (Philosophical Problems of Technical Knowledge), Moscow: Nauka, 1984.
50. *Fundamental'nye i prikladnye issledovaniya v usloviyakh NTR* (Fundamental and Applied Research in the Scientific and Technological Revolution), Novosibirsk: Nauka, 1978.
51. Wells, H.G., *The Great Science Fiction: The Time Machine, The Island of Doctor Moreau, The Invisible Man, The War of the Worlds, Short Stories*, Penguin Classics, 2016.
52. Peccei, A., *The Human Quality*, Oxford: Pergamon Press, 1977.
53. Harari, Y.N., *21 Lessons for the 21st Century*, London: Jonathan Cape, 2018.
54. Semenyuk, E.P., The information effect of transdisciplinarity in the concept of sustainable development, *Sci. Tech. Inf. Process.*, 2019, vol. 46, pp. 1–13.
55. *World Environmental Constitution. Methodological Foundation*, Tunytsya, Yu.Yu., Ed., Lviv: Ukr. For. Univ. Press, 2014.