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Philosophy and methodology of scientific research

(lecture notes for graduate students)

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Lecture notes correspond to the course program for graduate students of ONPU. It briefly presents the philosophical and methodological problems of the structure and dynamics of scientific research, the features of natural science, technical and humanitarian knowledge, external and internal factors in the evolution of science. The abstract is intended for graduate students of all specialties, can be used by students, masters, teachers and everyone who is interested in the modern vision of science and its philosophical and methodological features.

Content

1. The subject of philosophy and methodology of science.

1.1. Disciplines that study science.

The sociology of science explores science as a social institution, its connections with the structure of society, scientific teams as social groups, types of scientists and the typology of their behavior, the interaction of formal and informal communities of scientists, the dynamics of their group and intragroup interactions.

Science of science mainly studies the interaction of science with those social spheres on which the effectiveness of science depends, and develops recommendations for the organization of state or sponsored scientific policy.

Scientometrics is a field of statistical study of science as an information array, flows of scientific information (scientific publications, reference apparatus, growth of scientific personnel, financial costs).

The history of science studies the history of scientific discoveries, the emergence of theories and the circumstances that influenced them. It also constructs some model, scheme, theory, interpreting facts from the history of science in a special way.

The psychology of science studies the psychological characteristics of the production of new knowledge. The logic of science studies the patterns of scientific discovery.

The philosophy of science reveals the prerequisites for scientific thinking and activity, clarifies the concepts and theories of science, determines the specifics of scientific thinking, the conditions of scientificity, the ideals and norms of science. In contrast to the methodology of science, with which, however, it is often considered in unity, it focuses on the epistemological, philosophical-ideological, philosophical-methodological, rather than scientific-methodological and logical-methodological aspects of science.

The methodology of science is a discipline that studies the regulations of scientific activity, primarily scientific methods and procedures, the scope of their applicability, the validity of scientific results, the patterns of development of scientific knowledge, analyzes the stages of scientific research, the language of science, research principles. It differs from a methodology that offers a description of specific actions and procedures.

Scientism and anti-scientism in the philosophy and methodology of science. The scientistic version of the philosophy of science highly appreciates the role of science, proves that there is no alternative to scientific and technological progress, denies the shortcomings of science or justifies them. The solution of all human problems and the salvation of mankind from the modern civilizational crisis is entrusted to science.

The anti-scientist philosophy of science demands the equality of science and extra-scientific ways of seeing the world, criticizes the scientific rationalistic worldview, blames science for allegedly being a source of dogmatism and totalitarianism, that it is responsible for global problems and the crisis of civilization.

Scientism and anti-scientism in the philosophy of science are two extremes. In fact, both positions are partially true. Indeed, science is responsible for the crisis of civilization. But, firstly, not only science bears responsibility for this, and secondly, it is possible to overcome the crisis, solve global problems that threaten the very existence of mankind, only on the path of the development of science.

1.2.Philosophical and methodological problems of science.

Methodological problems, which are sometimes also called scientific and methodological, can be divided into general **methodological**, when the prerequisites for scientific thinking and activity are studied, the specifics of scientific thinking, the conditions of scientificity, ideals and norms of science are determined, and **particular methodological**, when scientific concepts and theories are clarified, the nature of the methods, the conditions for their adequacy, scientific procedures, and others.

Worldview, ontological, epistemological, cognitive, axiological, sociocultural problems of science can have an independent philosophical meaning, but often have methodological meaning, especially when the solution of specific methodological problems of science depends on them: the choice of the researcher's starting position, the choice of a method or theory, the production of hypotheses, the formulation goals, a way to substantiate scientific provisions, and much more.

The ideological problems of science are usually called those on which the ideas about the world, about man, his place in the world depend.

Worldview problems merge with **ontological ones**. Among ontological problems, ideas about the device, the structure of the world stand out. They are the worldview-ontological background of scientific reasoning, and often a direct methodological premise. For example, ideas about whether the world has a corpuscular or field (wave) nature underlay the discussion between Newton and Hooke on the nature of sound. Newton believed that sound was carried by particles, and Hooke represented it as a wave process. Newton won the discussion, although it turned out later that he was wrong.

The epistemological problems of science are connected with one or another understanding of scientific knowledge in terms of its relationship with the object. When scientific knowledge is considered in line with the relationship with the subject, this is referred to as epistemological issues. However, it is not always meaningful to distinguish between epistemology and epistemology.

An example of an epistemological problem: scientific knowledge can be understood as a reflection of reality, or it can be understood as the fruit of an agreement, convention between scientists. The latter is a consequence of the philosophical concept of conventionalism. For example, the famous French mathematician Henri Poincare was on the verge of discovering the special theory of relativity, in any case, he knew all those provisions that would later form the essence of this theory. But he did not take the decisive step, because his conventionalism did not presuppose either scientific ambitions or any other theoretical presentation of the known facts. Albert Einstein, on the contrary, he proceeded from the opposite epistemological premise, in which knowledge was considered as a reflection of reality, therefore, the more correct this reflection in theory, the better for science. He took the decisive step, and the theory of relativity rightfully bears his name, although attempts have been made to ascribe primacy to Poincaré.

Cognitive problems in the methodology of science are associated with the concept of knowledge in terms of its acquisition, storage, representation, transformation, reproduction. Of course, epistemological and epistemological concepts are used in cognitology. But here the concepts of artificial intelligence, decision theory, information theory, separate sections of psychology, linguistics, microbiology are connected. The cognitive approach was largely stimulated by the ideas of Popper's "third world", Polanyi's "personal knowledge", Kuhn's "paradigm" and other ideas of representatives of the philosophy and methodology of science.

Axiological problems in the methodology of science began to be investigated relatively recently, when it became clear that, in addition to knowledge, values function in science, and often they are non-rational in nature. It is also important that, along with purely scientific values, which are usually well understood: truth, scientific professionalism, objectivity, the validity of scientific results, etc., extrascientific, but important values work in science, for example, ethical, aesthetic, and sometimes political ones. , and even narrow-group ones. Many values acquire a methodological character, since they often directly or indirectly regulate scientific activity. Sometimes, in order to evaluate a scientific project, it is necessary to resolve the question: what values are its basis.

Sociocultural problems in science arise when it is necessary to analyze and take into account the social and cultural environment of science that directly or indirectly enters into the fabric of scientific research or at least influences it. In hindsight, this is almost always done when subsequent generations of scientists and methodologists explain the mistakes or shortcomings of their predecessors by "the conditions of that time." Taking into account socio-cultural inclusions and the socio-cultural context of science allows not only to better understand the predecessors, but also to identify the rational grain of their work that can be used.

1.3.Philosophy and methodology of science in the light of philosophical doctrines.

Scientific and methodological issues were already addressed to one degree or another in the 17th century, when classical science was developing. This is evidenced by the methodological ideas of the English philosopher **Francis Bacon**, as well as the rules for guiding the mind of the French thinker **René Descartes.**

At this time, concrete empirical material was accumulating, it had to be somehow ordered on the basis of certain methodological principles and rules, which were precisely proposed by Bacon and Descartes. Their methodological attitudes were opposite, which was due to the different areas of natural science in which they worked. Bacon's methodology is called empirical-inductive, and Descartes' methodology rationalistic-deductive. What they had in common was that they had the same understanding of the goals of methodology: to improve the methods of cognition so that man would dominate nature more and more.

Meanwhile, the successes of the sciences and their growing isolation from classical philosophy provoked ideas about the possibility of complete independence of science from philosophy. In 30-60 years. In the 19th century, **positivism** emerged as a philosophical and methodological direction, which focused on the so-called "positive" knowledge, that is, knowledge obtained in specific sciences. The study of methods for obtaining such knowledge and the creation of an appropriate methodology will allegedly allow us to get rid of the metaphysical premises of science (Auguste Comte, John-Stuart Mill).

Sometimes there is a so-called **second generation of positivism**, represented, for example, by Ernest Mach. These positivists analyzed the changes in science that took place in the second half of the 19th and early 20th centuries and tried to single out the substantive foundations of science. The greatest scientists of that time also tried to understand the philosophical foundations of science: Henri Poincaré, Albert Einstein, Niels Bohr, Max Born and others.

In the non-classical philosophy of the late 19th - early 20th century, a cardinal revolution took place in the approach to the problems of methodology. This is primarily due to the revision of the fundamental role of rationalism in scientific knowledge and, accordingly, the revision of the methodological foundations of scientific knowledge. Radical criticism of rationalism was carried out by Friedrich Nietzsche, the founder of the **"philosophy of life"**, giving primacy to irrational means of knowledge: instinct and intuition, guided by the will to live. Henri Bergson (1859-1941), Heinrich Rickert (1863-1936) began to explore the cognitive possibilities of intuition in comparison with the intellect and create an appropriate methodology. The result of such studies was the distinction between the sciences of nature and the sciences of values (natural sciences and the humanities). Bergson is called the founder of the philosophy of **intuitionism**, and Rickert, along with another famous philosopher Wilhelm Windelband, are called **neo-Kantians**. From the neo-Kantians comes the now popular, albeit controversial, point of view that natural science studies the laws of nature, and the humanities study the unique phenomena of the human spirit and culture.

Another attempt to revise the priorities of classical philosophy was the **phenomenology** of Edmund Husserl (1859-1938). Phenomenology is the doctrine of the method of intuitively contemplative "consideration of the essence" due to phenomena, that is, a special form of consciousness. This or that semantic content demonstrates itself through them. Appeal to the "phenomenon" as an element of the flow of experiences required its purification from abstract, predetermined knowledge and concepts, for which a special procedure of phenomenological reduction was intended. The development of the phenomenological method meant the restoration of confidence in the intuitive-contemplative processes of consciousness.

Hermeneutics originated as the ancient art of interpreting sacred texts. It acquired a new meaning from the German romantics Friedrich Schlegel and Friedrich Schleiermacher at the turn of the 18th and 19th centuries, and was conceived by them as the art of understanding someone else's individuality. The methodology of hermeneutics was developed by Wilhelm Dilthey (1833-1911), who defined hermeneutics as the art of understanding written manifestations of life. One of Husserl's students, Martin Heidegger (1889-1976) gives a new understanding of the phenomenological method, defining it as hermeneutic phenomenology. Heidegger interpreted the reality of the "life world" mainly as a linguistic reality, hence its "contemplation" originates as listening, that is, observing what is heard in the word, in the language.

Further development of philosophical hermeneutics was carried out by Hans-Georg Gadamer (1900-2002), a student of Heidegger, for whom the meaning of hermeneutic experience lies in the interpretation, interpretation of what the text reveals, carrying out its game. From a methodological point of view, Gadamer's reasoning about prerequisite knowledge, which he calls "prejudice", in the sense of what precedes reasoning, is interesting. Prejudice predetermines the understanding of any text by the researcher. An important task of hermeneutic methodology is to ensure that the scientist does not become a slave to prejudice. In the second half of the 20th century, the problems of hermeneutics were considered by Paul Ricoeur and others.

The problem of language, meaning and meaning was eventually reached by thinkers who represented a completely different direction in the philosophy of the twentieth century - **neopositivism**. Neo-positivism emerged as a historical form of positivism in the early 20s of the 20th century, and one of its first trends is **logical positivism**, represented by Max Schlick (1882-1936), Rudolf Carnap (1891-1970). For logical positivism, as well as for positivism of the 19th century, the desire to eliminate metaphysics from scientific knowledge is characteristic, and scientific philosophy is considered by him only as a logical analysis of the language of science in order to identify the “immediately given”, that is, the content of scientific concepts. This orientation of logical positivism is connected with the real methodological problems of science in the 20th century. At this time, the role of sign-symbolic values is becoming more and more recognized, the tendency of mathematization and formalization of knowledge is intensifying, and the dependence of ways of viewing reality on the type of language is revealed. Closely related to logical positivism is analytic philosophy, represented by such neo-positivist thinkers as Bertrand Russell (1872-1970), Gottlob Frege (1848-1925), George Moore (1873-1958), Ludwig Wittgenstein (1889-1951).

The next step was **post-positivism**. Its prominent representatives: Karl Popper (1902-1994), Imre Lakatos (1922-1974), Paul Feyerabend (1924-1994), Thomas Kuhn (1922-1999). In general, postpositivism moves away from very rigid formulations regarding the exclusion of philosophical propositions from scientific knowledge, fixes the changeability of scientific paradigms and the role of philosophical theories in this process, and recognizes the role of extrascientific factors in updating scientific knowledge.

An alternative to postpositivism as a methodological concept is the **cultural-historical approach** (Michel Foucault and others), in the development of which Soviet philosophers also took part (Boris Gessen, Vladimir Bibler, Piama Gaidenko, and others). Proponents of this approach focus on the study of the historical dynamics of science as an organic part of culture as a whole and its individual types (historical and national cultures). The main problems of this direction: the analysis of the cultural and historical prerequisites for the birth and development of science, the features of the main cultural and historical types of science, the dependence of science on the characteristics of national cultures.

Recently, the philosophy of science has been influenced by **postmodern philosophy**. Postmodernism is characterized not only by an interest in linguistic and meaning-forming structures, but also in virtual forms of meaning-making, representing simulation models of thinking - simulacra, as well as an interest in the structures of everyday life that form human consciousness and influence science.

Postmodern or postmodernism literally means that which is after "modern". Modernity is understood as a set of ideas that determined the modern era, but developed in modern times and especially in the Enlightenment: faith in progress, reason, science, truth, freedom. The term "postmodern" began to be used at the beginning of the 20th century and became widespread in the sixties, fixing innovations in architecture, literature, art, and in the eighties it began to be used in philosophy thanks to the French philosopher Jean-Francois Lyotard (1924-1998). Postmodernism means awareness of the crisis of classical philosophy and, in general, the rational type of culture in which modern humanity lives.

One of the foundations of postmodernism is **poststructuralism**. It originated in the 1970s. as one of the currents of linguistic philosophy. The leaders of poststructuralism were Jacques Derrida, Jacques Lacan, Roland Barthes, Julia Kristeva and others. If it was previously believed that truth and meaning are inside the text, then from the standpoint of poststructuralism they are outside the text and belong to the author or interpreter (reader of the text). Truth and meaning are always generated during the interaction of one subject (reader) with another (author). Therefore, any truth is always not only relative, but also subjective-personal.

Postmodernity is also associated with fundamental shifts in forms of thought and research problems. For example, the classics of philosophy, science, methodology did not focus on absurdity, madness, sex, and the state suppressed these processes. From the point of view of postmodernists, reason has already led humanity to a dead end of global problems and put it on the brink of death, therefore reason, science, logic cannot be trusted. A person must live by emotions, intuition, play. For postmodernity, the main thing is freedom in everything: in creativity, in culture, freedom turning into chaos. However, it can be assumed that the state of chaos will sooner or later settle into a system of a new level. There is every reason to expect that the future of the philosophy and methodology of science will be determined by its ability to generalize and comprehend the accumulated scientific and cultural experience.

The Soviet philosophy of science was built on the philosophical principles of Marxism, with difficulty overcoming ideological and dogmatic resistance, expressed either in the defeat of scientific teams, or in noisy critical campaigns, or in control over publications. In the Soviet version, the philosophy of science could exist only as a criticism of foreign philosophy of science. Fortunately, creative, critically thinking philosophers who eschewed the philosophical dogmatism of Marxism-Leninism flocked to this field of activity, so their critical works often looked like propaganda of interesting foreign ideas. After 1985, a productive dialogue began with Western methodology, logic and philosophy of science. Now in the post-Soviet space, the philosophy of science basically does not separate itself from the world philosophical and methodological thought. A well-known contribution to the philosophy of science was made in the Soviet and post-Soviet period by V.S. Stepin, V.N. Porus, L.A. Mikeshina, V.S. Shvyrev, E.A. Nikiforov, V. G. Gorokhov, M. A. Rozov, V. P. Filatov, as well as well-known philosophers and methodologists of science who worked in the Soviet, and then in independent Ukraine: M. V. Popovich, A. I. Uemov, S. B. Krymsky and others.

2. Science and scientific outlook.

2.1. Components of science. The language of science. Science as the production of new knowledge.

Science is a field of research activity, which includes scientists, scientific organizations, scientific knowledge and special means of obtaining and expressing them.

Scientists are specially trained specialists who form scientific communities and perform scientific work in special institutions.

Scientific organizations and communities publish scientific works of scientists and assign scientific degrees and knowledge, which is a formal sign of a scientist. Modern scientific organizations have a complex structure, including national academies of sciences, research institutes, laboratories, departments, etc. Often they receive financial and organizational support from the state, but they can also be independent, with their own financial and organizational structure. Scientific societies, both formal and informal, play an important role.

Scientific knowledge, for the production of which science exists, is knowledge that has special features, for example, verifiability and is organized in a special way, for example, into a theory.

Special ways, methods of obtaining knowledge and special means of their expression and connection, for example, logic and a **special language**.

The language of science is characterized by unambiguity, clarity and accuracy of the meaning (as well as interpretation) of concepts and symbols. In many ways, the perfection of the language of science is associated with the development of mathematics, its means and methods. In reality, the language of science exists within scientific communities, and the adoption of this language also means the acceptance of a given system of views, as well as a given way of understanding scientific problems. One can speak about the language of classical mechanics, quantum mechanics, and so on.

Since theories speak different languages, researchers rarely understand each other well, especially when a new theory is emerging, or in related fields of science. For mutual understanding, the carriers of various theories often use metaphors, analogies, etc., which in turn raises the problem of clarifying the language of science.

Specific features of science:

1) Activity to increase new knowledge. The essence of science determines new knowledge. The whole point of studying existing knowledge is to produce new knowledge on its basis. This is called **continuity** in science. Scientific continuity is an integral part of scientific novelty.

2) The intrinsic value of science, that is, production of knowledge for the sake of knowledge itself. At the same time, in scientific works, for example, dissertations, it is necessary to indicate the practical significance of the proposed ideas. The requirement for practicality stems from the desire to avoid the complete speculation of scientific hypotheses and to demonstrate their potential utility.

3) The rationality of science is a rejection of the imagery and emotionality inherent in everyday experience and common sense, as well as other ways of relating to the world, for example, art and religion. Rationality is also a rejection of faith inherent in mythological or religious consciousness, and a transition to reliance on reason, argumentation, validity, evidence.

4) Systematicity as a special organization of science. It means that scientific activity, the functioning of scientific organizations, and, above all, scientific knowledge itself are combined into a system based on certain principles, for example, it is organized in the form of a theory, with its own strict structure, mandatory elements, and forms of presentation.

2.2. Classification of sciences. Science, technology, production.

Science is divided into branches of knowledge, special sciences, and scientific disciplines. A scientific discipline is a field of scientific knowledge that has a fairly defined subject area and fairly developed scientific research techniques. Traditionally, sciences are included or transformed into certain disciplines largely for the sake of teaching convenience, from which the differentiation of scientific knowledge and the corresponding training of specialists gradually develop. Within the framework of these disciplines and their differentiated sections, relevant scientific research is also carried out.

The classification of sciences involves the disclosure of their relationship on the basis of certain principles and the establishment of their hierarchy in the form of a logically justified arrangement.

Based on various needs, the classifications of modern sciences are carried out on a variety of grounds. According to the subject and method of knowledge, sciences are distinguished: 1) about nature - natural sciences: chemistry, physics, biology, 2) about society - social sciences: political science, sociology, legal, economic sciences, 3) about the human inner world, expressed in various texts - the humanities: history, literary criticism, psychology, 4) about technology - technical sciences.

According to the general nature of the tasks being solved, as well as the degree of proximity to the production of science, they are divided into two large areas: **fundamental**, which clarify the most general (fundamental) laws of reality, and

applied, focusing on the application of the results of scientific knowledge to solve industrial and socio-cultural issues. If we carefully trace the connection with production and with practice in general, it turns out that the influence of the fundamental sciences is much stronger than the applied ones, since the applied sciences are very tangibly dependent on the fundamental sciences and use their developments. This influence does not affect immediately, but in the long run. Applied sciences, as a rule, give a quick effect, so it seems that they are more important. But as soon as funding for fundamental research weakens, applied sciences begin to suffer very quickly.

2.3. Features of the scientific worldview, the difference from the artistic, philosophical and religious development of the world.

Science and art. The picture of the world presented by science is characterized by objectivity, i.e. the lack of interest of scientists in one way or another of its representation. If in science the basic unit is a scientific concept, then in art it is an artistic image. Artistic and figurative exploration of the world is necessary for a person, since in a bright, psychologically easily perceived form it affects a person, awakening the corresponding feelings and emotions. Art appreciates the singular, the unique, in which the most important thing is focused. Even an artistic type, as a general idea of something, is always presented in a single, unique form. And in science, it is the generality and repeatability of the observed data that is the highest value, behind the repeatability is hidden the law, that is, that form of universality, for the sake of discovering which science exists.

With all the originality and dissimilarity of science and art, there is much in common between them, especially the creative nature of the activity. In addition, the imagery and metaphor inherent in art often play a huge role in understanding the subject of scientific research and its knowledge. One can recall the planetary model of the atom or “encryption of hereditary information in genes”, and the very term “scientific picture of the world” suggests a certain image. Scientific and artistic creativity is impossible without intuition, although its role is different in these areas, but it is present both there and there.

Science and religion. Scientific knowledge is independently substantiated by special observations, experiments, special forms of reasonable arguments. In this, science differs from religion based on faith, on the authority of Holy Scripture, and in general on positions taken without justification.

In contrast to the religious and mythological exploration of the world, science focuses on the natural, and not the supernatural, determination of phenomena; seeks to find a cause, not a predetermined goal; possesses criticality as the ability to revise established provisions, in contrast to the uncritical assimilation of religious dogmas and prescriptions. In principle, both of these worldviews may well coexist, as can be observed in many countries. After all, they basically talk about different things, and science cannot make the main tenets of religion, for example, the existence of God, an object of study. Moreover, many people need faith in something miraculous, supernatural, saving, absolute.

Science and ordinary worldview. Science differs from ordinary knowledge, which is characterized by unsystematic, randomness. Ordinary consciousness plays a very important role in human life, as it accumulates life experience. Folk wisdom, as a collective image of everyday knowledge, has always deserved attention and helped in solving simple everyday problems. But science rises above everyday tasks, above individual everyday knowledge. Unlike everyday consciousness, science goes beyond the immediate given, focuses on objects and methods of activity that may take place in the distant future. Science is directed to special objects that are not reducible to objects of ordinary experience, uses a special language that is not reducible to natural language, relies on a special system of means - scientific equipment, special methods. Ultimately, the ordinary worldview is the result of ordinary knowledge.

Ordinary knowledge is a special type of rationality, a form of spiritual exploration of the world, directly related to real life. The result and at the same time the fundamental principle, the method is common sense, and not, for example, the theory or law of science.

Common sense is knowledge, beliefs, norms, values spontaneously formed in everyday life, which are the basis of human activity. Common sense accumulates experience, absorbs certain traditions, and therefore participates in both practical and scientific cognitive activity, as a rule, has an implicit expression, and is not subjected to rational processing in ordinary experience. Often the ideas of common sense are contradictory, incomplete, superficial, uncritical, and therefore limited.

Scientific knowledge as a whole opposes common sense, rises above it, overcoming its prejudices, inertness, situationality. At the same time, science cannot replace common sense; it remains an important component of public and private life. Common sense is also present in science as a property of the subject, which relies on the common sense of both his own and the whole era. But for mankind, science and philosophy are much more important than ordinary experience, and in the scientific or philosophical knowledge that mankind preserves and develops, ordinary experience and common sense are the object of ridicule and criticism.

Specificity of science and philosophy as forms of mastering the world. Science is similar to philosophy in many ways, for example, in the use of precise concepts, in criticality, reflection, and the validity of its provisions. Science learned this from philosophy, which used these qualities in antiquity. But science differs from philosophy in a number of ways. Science does not use a philosophical categorical apparatus that allows one to reason about extremely general things, so often their essence eludes it. The problems of the essence of the world, the essence of man, the meaning of life or being in general, and others can only be the subject of philosophical research. But science uses some methods that enhance the rationale, for example, experiment. However, science and philosophy are not in a state of confrontation, but complement each other and influence each other, which is especially noticeable in the philosophy of science.

Science solves relatively partial problems of mankind: technical, economic, educational, legal, etc., limited to certain parts of the world. Science is limited by the rational comprehension of the finite. Philosophy is interested in the world as a whole, the unity of all things, the essence itself. If science is interested in the beginning, then philosophy is the beginning, if science is interested in the cause, then philosophy is the root cause, if science determines the general, then philosophy is the general. Science prefers to find the single best solution to a problem. Philosophy seeks to present all possible outcomes, each of which is no worse than the others. Philosophy has an active impact on being, like science, but in a different way, namely through the formation of new ideals, norms, values.

2.4. The role of science in modern education and personality formation.

The scientific picture of the world is the basis of modern education. The meaning and content of any level and any form of education constitute the relevant scientific disciplines. Scientific knowledge is also an integral component of the organization of the education system itself. The role of science in education extends to all components of the educational process: goals and means used, initial principles and results, forms and methods, and the entire education system. Philosophy often comes in at this stage, suggesting a certain type of educational philosophy. However, it is associated with one or another scientific concept: psychological, pedagogical, physiological, didactic, economic, etc.

In addition, in the course of education, the formation of personality takes place. And this is not only the transfer of certain knowledge, but also familiarization with cultural and national traditions, the development of creative abilities, moral and aesthetic education, etc. But still, science is the most powerful factor in shaping a person’s attitude to the world.

The dissemination of scientific knowledge is important not only in terms of training future scientists. It is important to form **scientific education** among those people who will not be professionally engaged in science. Without this kind of foundation, science may be misunderstood in society, perceived as unnecessary or harmful.

Modern science is sometimes called **Big Science**, given the extensive system of organization and production of scientific knowledge, the developed system of scientific communications. At the end of the XX century. The number of scientists in the world exceeded 5 million people. Science includes about 20 thousand disciplines and several hundred thousand scientific journals. And the point is not only in these quantitative indicators, but in the transformative, and sometimes dangerous, role played by modern science. That is why it needs not only to be developed, but also to be thoroughly studied, which is what many disciplines do, including the philosophy and methodology of science.

Particularly important is a comprehensive and holistic understanding of science and its connection with other worldview forms **at the university stage** of professional education of a future scientist. In technical universities, especially in the post-Soviet space, there is a strong flawed philosophical and methodological attitude, dating back to Soviet times. According to it, philosophy, or another humanitarian discipline, should help a specialist in his development, find himself in his professional thinking. In this case, the thinking and worldview of a specialist is narrowed to an indecently narrow limit, reduced to professional thinking and professional worldview. Wits call it professional cretinism. Having no ideological, general scientific, philosophical, humanitarian training, he judges everything from the position of his specialty: philosophy, science, education, public interest, politics, family, etc. The disadvantage of such a position is obvious to a well-educated person, but not to a "narrow" specialist. Of course, a specialty should be narrow, but specialized knowledge should fit into a broad education, into a humanitarian worldview, into philosophical, methodological and general scientific ideals and norms, but not vice versa. On the contrary, it is dangerous even for science itself. Its disintegration into independent special knowledge, methods, disciplines without focusing on general scientific norms, values, ideals can destroy science, because then each field of knowledge will declare itself an independent, specific science, with its own vision and application. Then there will be no difference between science and pseudoscience, antiscience and non-science in general. Everything will be science, but there will be no science itself. Will scientific and technological civilization survive without science? The answer is obvious: no.

3. The emergence of science and the main stages of its development.

3.1. The problem of periodization of the history of science. Elements of scientific character in the era of antiquity, the Middle Ages, the Renaissance.

Periodization of science. All the signs of science correspond only to the knowledge that develops at the end of the 16th - beginning of the 17th century, when scientific professional work, scientific communities, and scientific publications arise.

The following periodization of science is most justified:

1. Pre-science, including knowledge of antiquity, the Middle Ages and the Renaissance. Sometimes knowledge is added here, known to the priests of Babylon and Egypt, as well as existing in ancient China and India.

2. Science, divided into three stages:

- classical (XVII-XIX centuries), which eliminates everything that relates to the subject and its means, achieving objectively true knowledge, the ideal of which is mechanics and Laplacian determinism, and the clock mechanism is the image of the world;

- non-classical (late 19th - first half of the 20th century), which takes into account the dependence of knowledge on the means of the subject's activity, the ideal of which is quantum theory and statistical determinism, and the image of the world is the flow.

- post-non-classical (second half of the 20th - early 21st century), which takes into account the correlation of knowledge not only with the peculiarity of the means of the subject's activity, but also with its value-target structures, the ideal of which is synergetics, self-organization and "random" determinism, but world - integrity and development.

Background of science in the era of Antiquity. Amazing knowledge can be found in the civilizations of the Ancient East, India, China. They concerned mathematics, chemistry, medicine, pharmacology, psychology. But all this "eastern" knowledge had at least two specific features that prevented them from becoming scientific: 1) the knowledge was of a religious-mystical sacral-ritual nature, 2) the knowledge was of a prescription nature, there were no theoretical generalizations.

A lot of knowledge was produced in antiquity, some of which was used by the science of modern times, like the geometry of Euclid. But the main thing that turned out to be the achievement of ancient civilization and what constituted pre-science - the basis of future science, is the creation of a special mental space from the most important ideas and methods. These include the idea of Parmenidean being, atomistic teaching, Aristotelian logic, the concept of theory, theorems, proofs. In this space, even misconceptions, which were subsequently rejected by science, had a positive meaning, developing thinking, thought procedures, ways of substantiating and building knowledge. An example is Aristotle's physics, which distinguished between the supralunar world, where there is an ideal circular motion of bodies, and the sublunar world, where the motion is imperfect. Thanks to the idea of circular motions, Aristotle presented the motions of the planets and stars in such a way that for more than two millennia his picture of the cosmos was only supplemented and not revised until the advent of scientific astronomy.

Background of science in the Middle Ages. The era of the Middle Ages covers approximately II-XIV centuries. The Christian worldview was self-sufficient and did not need predecessors. It began and ended in God. On the one hand, this meant the fall of the role of knowledge, on the other hand, it meant the beginning of the formation and development of another culture of knowledge based on religious faith.

In the Middle Ages, spheres of activity developed that prepared the possibility of the birth of science: astrology, alchemy, natural magic. You can name both the figures of the early Middle Ages, especially Aurelius Augustine, and the late Middle Ages, where, in addition to Albert the Great and Thomas Aquinas, Anselm of Kentenbury, Pierre Abelard, Jean Buridan, William of Ockham, and others were very famous. Occam, for example, owns the famous methodological device «**razor Occam**», which scientists still use today: from two hypotheses, other things being equal, one must choose the one that contains fewer assumptions, and cut off the other like a razor.

Among the authors of medieval pre-science, it is impossible not to mention the thinkers of the **Arab Middle Ages**, who, especially after the Arab conquests, had a significant impact on European intellectual activity. The works of the thinkers of those countries that ended up on the territory of the Arab Caliphate were translated into Arabic. This is how the works of Ptolemy, Euclid, Aristotle, Archimedes and others were translated, who after some time returned to Europe already in Latin, thanks to which the Europeans rediscovered them. Al-Khwarizmi, Al-Farabi, Al-Biruni, Omar Khayyam, Ibn-Sina (Avicenna), Ibn-Rushd and others are the pride of Arab and European intellectual thought.

However, the significance of the knowledge left by medieval thinkers, both Europeans and Arabs, for future science should not be exaggerated, after all, they had a philosophical and theological meaning and did not meet the standards of scientific character. Much more important for future science were not scientific facts, but ideas that prepared the intellectual ground for future scientific theories. Among these are the idea of dual truth and the idea of imaginary assumptions.

The meaning of the idea of **dual truth** is as follows. God created the world, therefore, put his knowledge into it. The same divine knowledge is presented in the Holy Books. As a result, we can talk about two pictures of the world that cannot contradict each other, because, ultimately, they have one source - God. Later the idea of dual truth was transformed into the idea of two divine books: the book of Holy

Scripture and the book of Nature. Thus, the possibility of studying nature was substantiated by divine authority, which was of decisive importance for the emergence of science.

The idea of imaginary assumptions. Since God was considered omnipotent, it is easy to imagine that he could create an infinite universe or that he could put the Sun at the center of the universe, and not the Earth. Imagining such an assumption, it was possible to draw conclusions and mathematical and astronomical calculations from it. Approximately so argued, for example, Nicolaus Copernicus, creating his heliocentric system. Even when, half a century later, Copernicus' teaching was banned by the church as a heliocentric system of the world, his heliocentric model, as an imaginary assumption, was allowed for all sorts of calculations.

The idea of imaginary assumptions has been used in various contexts. For example, if God is omnipresent, then it is easy to assume that it does not matter for him where to stay, in the supralunar or sublunar world, for him these worlds are equivalent, homogeneous. Without the idea of the homogeneity of the world, Newtonian mechanics would be impossible.

Background of science in the Renaissance. In the Renaissance, a new philosophical concept of **pantheism** arose, which means God in nature or God everywhere. An important conclusion followed from this concept: if God is present everywhere, then God's spark is also in man, and since God is the Creator, it means that man can be a creator. Renaissance pantheism approves of creativity, and it becomes a hallmark of so many activities: from tailoring to painting.

The great creator, titan of the Renaissance, Leonardo da Vinci introduced the idea of **pictorial perspective into painting**. Artists have never painted like this before. Justifying the need for this creative breakthrough in painting, he singles out the main one among other arguments: **one must paint as the eye sees**. This meant trust in feelings, which, it turns out, mean no less than reason. It is symptomatic that Galileo will then justify the role of science in much the same way: science must describe what the senses “see”.

Renaissance thinkers did a lot for future science, especially Nicholas of Cusa and Giordano Bruno.

Nikolas Cusanskiy, cardinal of the Roman Catholic Church, the greatest thinker of the 15th century, philosopher, theologian, encyclopedist, mathematician, church and political figure. One of his main philosophical ideas was pantheistic. Since God is absolute and infinite, nature is also infinite, so it has no center. From this it followed that the Earth could not be at the center of the universe. This was of great importance for the development of scientific astronomy. His ideas had a significant influence on Giordan Bruno, Leonardo da Vinci, Nicolaus Copernicus, Galileo Galilei, Johannes Kepler and others.

Giordano Bruno, the pantheist philosopher, was a simple monk, moreover, who broke his vow, which was a serious crime at that time. His ideas are close to the teachings of Kuzants, in particular, he proved the infinity of the Universe. But his conclusions were more radical. So he substantiated many worlds, considered the stars as numerous suns, criticized the Aristotelian-Ptolemaic system, in the center of which is the Earth, opposed to it the heliocentric system of Copernicus, giving it an ontological meaning.

3.2. The emergence of classical science.

Features of the science of modern times. The period of the 16th-19th centuries belongs to the New Age. At this time, classical science was formed, which is usually identified with classical natural science, since social and humanitarian disciplines take shape later, in the 19th-20th centuries.

Galileo Galilei (1564-1642) is considered to be the founder of science. He established the principle of relativity of motion, for the first time formulated purely physical, that is, not anthropomorphic, laws of nature: the law of free fall of bodies, the law of inertia. Galileo was nicknamed the Columbus of the sky: he discovered spots on the Sun, mountains and depressions on the Moon, phases of Venus, clusters of stars in the Milky Way, etc. But the main thing is not even these discoveries of his, but those methods that formed the basis of Galileo's achievements, and those the conclusions that followed. It was they who determined the scientific nature of the new worldview.

Galileo began to apply the **method of observation**, using all kinds of devices, and placing objects in special conditions, which gave rise to another scientific method - **experiment**. His observations were not just contemplation, but purposeful activities, like experiments, using idealizations, abstractions, theoretical assumptions, mathematical understanding and analysis, which distinguished his experiments from ordinary experiments, and provided independent conclusions that medieval "experimenters" could not reach. .

These methods allowed Galileo to establish the peculiarity of science, in contrast to philosophy. Philosophy penetrates into the invisible essence of things, therefore it is not interested in experiments and descriptions of external, visible and observable characteristics. This is exactly what science should do, which, through the description of the observed, will establish regular relationships between the properties of things.

Francis Bacon and Rene Descartes played an important role in understanding the place and role of the new science. Bacon substantiates the methodological role of induction in scientific knowledge, the prospects of a new science. Understanding the transformative role of science allowed Bacon to formulate the motto: "Knowledge is power."

Rene Descartes develops rational-analytical methods, which, on the one hand, rejected, but, by and large, supplemented Bacon's empirical-inductive methodology. Subsequently, the followers of Descartes (Spinoza, Leibniz, and others) formed the philosophical direction of rationalism, and the followers of Bacon (Locke, Hume, and others) formed the direction of empiricism and sensationalism. Both those and others made a huge contribution to the development of philosophical-epistemological, philosophical-methodological, philosophical-ideological problems of natural science.

Among the great scientists of modern times who created a new science, the role of **Isaac Newton** (1643-1727) is especially great. Newton formulated the concepts and laws of classical mechanics, gave a mathematical formulation of the law of universal gravitation, theoretically substantiated the laws of Kepler, etc.

Newton completed the scientific revolution started by Copernicus. His mechanics of the herd is a classic example of a scientific theory of the deductive type and a standard of scientific theory in general, retaining its significance to the present day.

The main content of the mechanical picture of the world created by Newton is as follows. The entire Universe and all its objects from atoms to humans are a collection of indivisible and unchanging particles moving in absolute space and time, interconnected by gravitational forces, instantly transmitted from body to body through the void. Therefore, any phenomena are rigidly predetermined by the laws of mechanics, so that if there were an all-encompassing mind (Laplace's demon), then it could unambiguously predict and calculate any events.

The famous mathematician, mechanic, astronomer Pierre-Simon **Laplace** (1749-1827) did a lot to establish the mechanical picture of the world and, consequently, mechanical causality and regularity, resulting in the concept of mechanistic determinism, also called Laplace determinism.

In general, the **features of classical science** can be reduced to the following.

1. The leader of science is natural science, in particular Newtonian mechanics.

2. The ideal of scientificity is an objective reflection of the object.

3. Scientific research should include mathematical means and scientific methods: observation, experiment, measurement, as well as special mental procedures, which were later called theoretical methods: analysis, induction, deduction.

4. Scientific knowledge must be substantiated by both rational and empirical means.

5. Scientific knowledge is different from philosophical, religious, from art.

6. The scientific style of thinking is based on determinism, in particular Laplacian.

3.3. Scientific revolution of the late XIX - early XX century. non-classical science.

At the end of the 19th century, **a new scientific revolution** took place, which first of all changed the style of thinking, but also some fragments of the scientific picture of the world and the scientific worldview, although the basic ideals and norms of scientificity were preserved.

The first manifestation of the new scientific revolution was the **Maxwellian theory** of electromagnetic phenomena, due to which not only corpuscular, but also continual representations entered the picture of the world. The limitations of the mechanical picture of the world were also revealed in **geological and biological** studies, which showed changes in the earth's surface and living organisms. The cell theory has proven internal unity of the origin and development of all living things. **The theory of Charles Darwin** showed that plant and animal organisms, including humans, are the result of a long natural evolution, the driving forces of which were heredity and variability, as well as natural selection. Subsequently, Darwin's theory was confirmed by genetics.

Revolution in natural science in the late 19th - early 20th centuries. New revolutionary discoveries concerned mainly the structure of matter: X-rays were discovered, the phenomenon of **radioactivity**, an **electron**, an atomic nucleus were discovered. These discoveries showed the inaccuracy of previous ideas about the structurelessness, simplicity and indivisibility of the atom, that is, they undermined the very foundations of the former scientific picture of the world.

In 1900, the German physicist Max Planck discovered the action **quantum**, and soon the Rutherford-Bohr **quantum model of the atom** was proposed. Two incompatible ideas about matter arose: on the one hand, it is absolutely continuous, on the other, it consists of discrete particles.

In 1905, Albert Einstein proposed the special **theory of relativity**, which he then generalized and called the general theory of relativity (1916). The theory of relativity, unlike Newton's mechanics, proved the relativity of space and time.

In 1927, Heisenberg formulated the **uncertainty relation**, which establishes the impossibility of simultaneously accurately determining the coordinate and momentum of microobjects, due to their contradictory corpuscular-wave nature. The uncertainty principle has become one of the fundamental principles of quantum mechanics. In philosophical and methodological terms, he characterizes the statistical patterns of motion of microparticles.

All these discoveries in the field of physics have played a huge role in the development of science as a whole. Their significance has gone far beyond the limits of physics and even science, becoming a common cultural property.

Radical shifts were also taking place in other areas of science. In cosmology, a model of a **non-stationary Universe began to form**. From this followed the most important philosophical conclusion: the idea of evolution concerns not only the Earth, but the entire Universe. In chemistry, not only the rapid development of inorganic chemistry, especially the creation of the periodic system of chemical elements by Dmitri Mendeleev, but also the formation of organic chemistry, and then the emergence of quantum chemistry, were of great importance. Sociology and psychology began to develop actively, in particular, Freudianism arose as a medical, psychological and philosophical concept. Of no small importance was the fact that in the first half of the 20th century, reflections began on theories of systems, which would receive their development already in post-non-classical science.

Philosophical and methodological features of non-classical science.

1. In the description of objects, it was necessary to take into account the influence of the scientific means of the subject. But scientific knowledge must still be objective, independent of the interest of the subject.

2. Absolute reductionism was rejected as a requirement to reduce all phenomena to the atomistic structure of the world. But certain forms of reductionism were quite acceptable: certain biological phenomena were sometimes reduced to chemical interactions.

3. Rejected mechanism as a picture of the world. But in some areas of science, for example, in the study of the motion of large masses on the Earth, and in a number of applied sciences, mechanics retained its significance.

4. The absoluteness of space and time, the indivisibility of atoms, the immutability of chemical elements and species of plants and animals, the immutability of the stationary Universe were rejected. It became clear that scientific truth is relative. But the requirement for the immutability of scientific laws remained as a reflection of the stability (albeit relative) of the phenomena being studied.

5. Ideas about determinism have changed. Laplacian determinism is being replaced by statistical determinism.

6. Visibility and evidence, which the classics dreamed of, are no longer obligatory conditions for scientific principles, but the principle of observability remains.

7. While maintaining the classical ideals of justifying knowledge, for example, in an experiment or in a confirmed theory, a new ideal has been introduced: the correspondence principle formulated by Bohr: a new theory should not reject the old one, but include it as its limiting case.

8. If classical science as a whole moved away from philosophy, then non-classical science is moving closer to philosophy, realizing the philosophical significance of its discoveries, theories, conclusions, as well as the importance of philosophy for advancing scientific ideas. A frontier area of knowledge began to take shape: the philosophy and methodology of science.

4. Features of modern science

4.1. post-classical science. Modern understanding of determinism.

Scientific discoveries and background of the post-non-classical period.

1. In 1953 Francis Crick and James Watson **deciphered the structure of DNA**. This was a decisive step in the development of genetics. Within a short time, many sections and areas of genetics emerged, including genetic engineering and a wide range of practical applications of scientific knowledge, ranging from the creation of organisms with predetermined properties to the cloning of living beings.

2. In the second half of the 20th century, a **digital revolution** took place as a result of the development of computer technology. Thanks to it, a variety of objects and phenomena can be represented in a digital recording, ranging from photography or sound to the genome. It is difficult to overestimate the importance of digital technology for scientific research, especially the cutting edge of science.

3. In the second half of the 20th century, **synergetics** was formed and its ideas and methods began to be widely disseminated. Synergetics is called the theory of self-organization and development of complex open non-equilibrium systems of any nature with non-linear internal processes. The term "synergetics" was proposed by one of its founders, the German theoretical physicist Hermann Haken. But the Belgian physicist Ilya Prigogine stood at the origins of this approach.

The development of synergetics and its diverse applications continue, posing various philosophical and methodological problems of evolution, determinism, order and chaos, rationality, and others.

4. In the second half of the 20th century, **systemic ideas acquired great importance**, since science faced very complex formations with special internal structures. Systems research experienced a real boom in the 1950s and 1970s, when several general systems theories were created. Among them stands out the parametric general theory of systems by Avenir Uyomov, an outstanding philosopher, methodologist, logician, who worked for a long time in Odessa, who created an independent scientific school of system research. The representation of objects as systems makes it possible to single out special systemic patterns that are not found in ordinary research, and in a number of cases it is they that can be of decisive scientific or practical importance.

Main features of post-non-classical science

<u>The growing importance of humanitarian knowledge</u>. This is due not only to its rapid development, but to the fact that many concepts and methods of humanitarian knowledge turned out to be acceptable in other sciences. In addition, many modern objects of science are human-sized, so it is impossible to study them without the humanities. Attempts are now being made to technologize them, especially for all kinds of humanitarian expertise.

<u>Overcoming the gap between the object and the subject of knowledge</u>. Modern science is carrying out a grandiose global experimental dialogue with nature, which implies active human intervention not just in a separate object, but in nature as a whole. Therefore, it is impossible to isolate a person as the only possible observer from the surrounding world, to make him independent of the process of acquiring and developing knowledge.

<u>Renewed rationality</u>. In the second half of the XX century. revealed the historical, changeable nature of scientific rationality itself. A model of flexible rationality emerged. Flexible rationality is more adequate to the research task: to use rigid or flexible requirements, causal or narrative schemes of explanation, quantitative or qualitative methods and theories, to be determined by certain values and preferences (to formulate typical, general, regular, or vice versa, to show individual and singular).

Knowledge includes the goals of the subject. If classical science eliminated the goals of the subject from its knowledge, then post-non-classical science returns them. In this regard, the interest of modern scientists in the teleology of Aristotle has increased. Modern post-non-classical science can supplement the mechanism and regularity with target characteristics. This is especially important in the study of highly complex human-sized systems, where human goals can be decisive.

Narrative character of theories. The meaning of classical theories was that the explanation was carried out through the law, that is, the ideal was a nomological explanation. They tried to extend this ideal to humanitarian knowledge, in particular to history, trying to find laws there. However, this turned out to be unworkable. The majority of modern authors see in narrativity and other specific narrative structures included in descriptive and explanatory procedures an irremovable specificity of the humanities, fundamentally different from nomological explanations. Narrative structures are also found in many natural science theories, which is sometimes interpreted as a manifestation of narrative rationality.

Quality methods. If the ideal of classical and even non-classical science was quantitative research methods, then in post-non-classical science, qualitative research methods are becoming widespread, especially in the social sciences: economic, political science, sociological. The initial philosophical and methodological setting of qualitative approaches is the assumption that the researcher has his own subjective position, which must be taken into account.

Picture of the world. The picture of the world of post-non-classical science includes teleological and anthropic characteristics. In cosmology of the late XX - early XXI centuries. the anthropic principle was formed: the presence of an observer not only changes the picture of observation, but in general is a necessary condition for the existence of the material foundations of this picture.

Modern understanding of determinism. Philosophical and methodological studies of the phenomenon of post-non-classical science are often associated with the spread of synergetic ideas. Among them, at least two were of particular importance.

First, giving a universal character to the "arrow of time", expressing the irreversibility of not only social, but also natural processes. This required a revision of the classical ideas about the laws of nature, since the world was symmetrical in time, the formulas did not distinguish between the past and the future, which is why it was almost impossible to detect classical laws in sociocultural processes, and in natural science to represent development. Secondly, giving unpredictability and randomness a "legitimate" character. In systems far from equilibrium, fluctuations grow like an avalanche, and it is impossible to unambiguously predict the trajectory of objects and the future states of systems. Even if it is possible to determine the trend, it is not a fact that at any moment it will not change to the opposite. This is how irreversibility works, where there is an event, change, evolution, and where there is no dynamic equilibrium and classical laws. Synergetics tries to synthesize the arrow of time, i.e. irreversibility in the natural sciences with the reversibility on which scientific laws are based.

All this means the need to reconsider the principle of determinism. In the classical and non-classical versions of determinism, the future state of an object was easily predicted. This is not possible in an unstable object. Therefore, chance, not necessity, is responsible for the changes in such an unstable system. Where the trend is determined, classical or non-classical (probabilistic) determinism operates, and when the trend becomes uncertain and the object is unstable, post-non-classical (random, non-linear) determinism operates.

Biological forms of human existence are inseparable from socio-cultural ones, which makes both him and society non-linear, unstable, complex, irreversible and poorly predictable systems. In stable systems, irreversibility and fluctuations can be neglected, but it is not entirely clear in which cases the classical approach is sufficient, and in which the post-nonclassical, for example, synergetic approach is required.

4.2. The main features of modern science. Modern features of the connection between science and production.

The main features of modern science. Modern science includes the main features of post-non-classical science, but is not limited to them. Non-classical and classical approaches and ideas work successfully in certain areas of science and areas of its application.

Distribution of synergetic ideas. Thanks to the spread of synergetic ideas, such concepts as dissipative structures, bifurcation, fluctuation, strange attractors, nonlinearity, uncertainty, irreversibility, etc. have become very popular. The difference between the synergetic view and the traditional one is the transition from the study of simple systems to complex ones from closed systems to open ones, from linearity to non-linearity, from consideration of equilibrium processes to instability.

Rapprochement of natural and human sciences. For the end of the XX - the beginning of the XXI centuries. characterized by the convergence of the natural and human sciences, science and art. Ideas and principles that are being developed in modern natural science, especially in synergetics, are increasingly being introduced into the humanities, but the reverse process is also taking place. The development by science of self-developing "human-sized" systems erases the former impenetrable boundaries between the methodology of natural science and social and humanitarian knowledge.

Increasingly, scientists are **turning to the traditions of Eastern thinking**, which is associated with the awareness of the limitations of European rationalism and its methods. Understanding the prospects for the development of mankind suggests the possibility of a new synthesis of the Western tradition, based on experimentation and quantitative methods, and the ancient Eastern worldview, which represents the world as spontaneously changing and self-organizing.

The object of modern science has changed. The objects of modern science are increasingly becoming systems that are called human-sized: medical and biological objects, objects of ecology, often including the biosphere as a whole, objects of biotechnology, for example, genetic engineering, systems "man-machine", "man-computer", etc. If at the previous stages science was focused mainly on comprehending an increasingly narrowing, isolated fragment of reality, then the specifics of modern science are increasingly determined by **complex research programs** in which specialists from various fields of knowledge, interdisciplinary and transdisciplinary research take part. Often the methods of some theories are applied to others, which raises methodological questions, in particular, about the conditions and norms for the adequacy of methods.

Active application of philosophy in all sciences. The widespread use of philosophy is associated primarily with the emergence in science of human-sized objects and problems of global evolutionism, global ecology, which entails the formulation of limiting, philosophical questions. As a result, the philosophical and methodological function of philosophy is included, but also ontological, epistemological, worldview, axiological. All this requires the philosophical training of scientists and the involvement of relevant specialists-philosophers.

Methodological pluralism. Modern science is aware of the one-sidedness of any methodology. Therefore, one cannot limit the methods of one's research to the single most correct method of thinking, or to the most correct theory or philosophical attitude. Modernity requires from any specialist a broad scientific outlook and a good general education.

The role of non-scientific forms of comprehension of the world. In modern scientific research, intuition, fantasy, imagination and other similar factors and means of comprehending reality acquire a huge role. In modern science, they often talk about the aesthetic side of knowledge, about beauty as a heuristic principle, in relation to theories, laws, concepts.

Not the last role began to play non-traditional ways of understanding reality, which are mostly poorly understood and often unreasonably rejected by classical science. The border between science and non-science became more fluid, which, among other things, led to the success of non-professional "scientists". However, the number of anti-scientific concepts has also increased, the fight against which is becoming an important task of the philosophy and methodology of science.

Communication of science with production. An essential feature of modern science is the new scheme of connection with production. For example, discoveries in the field of chemistry almost instantly turned into production cycles. Almost directly from scientific laboratories, the production of plastics, synthetic materials, and artificial fertilizers arose. With the development of genetic theory and the advent of genetic engineering, the production of genetically modified products has been formed. Similar examples can be given for digital technologies and related products.

Thus, the current scheme of connection between science and production can be expressed as follows: **science-technology-technology-production**, where the leading role belongs to science, not only at the initial stage, but also at all subsequent ones.

In the technical and technological applications of science, both narrow-profile and complex, significant changes continue to grow, especially in connection with the development and spread of digital technologies. The essence of these changes is expressed by new concepts that are becoming widespread, behind which are new scientific and scientific-production realities. Among them:

– Transdisciplinarity, when several different sciences are combined, and the methods of one of them are used in all the others, bringing unexpected valuable results. Politicians, cultural figures, and generally caring people are often involved in transdisciplinary research.

- Non-institutional science, when temporary scientific or research and production groups are organized to solve some particular scientific or engineering problems, which quickly and efficiently solve the tasks.

– Crowd funding (crowd funding), when a certain scientific project is financed not by the state or a sponsor, or an owner who expects appropriate profits, but by a group of interested people who, for some reason, it is important to solve the problem, and not fame or profit, although one does not exclude the other.

– Crowdsourcing, when not only specialists are involved in solving scientific or innovative production problems, but people with creative abilities or relevant experience in innovative and communication activities, often on a voluntary basis.

– Prosumerism, when consumers are actively involved in the production of the product they consume.

4.3. The complex nature of scientific research. Transdisciplinarity.

A comprehensive study is carried out using a variety of methods and techniques, which sometimes can be combined into a system, but not always. The meaning of a comprehensive study is to cover the maximum or optimal number of important parameters of the object under study. Most often, scientists of different specialties collaborate in a complex study, sometimes close, but often quite distant from each other.

Interdisciplinarity implied cooperation, a kind of synthesis of various disciplines, approaches, and methodologies. However, the resulting generalized knowledge often means the emergence of a new discipline at the junction of the former. An example is social psychology and other binary scientific disciplines: biophysics, geochemistry, astrophysics.

Polydisciplinarity (multidisciplinarity) preserves the originality of each discipline, each approach, does not imply synthesis. Cooperation in this case is complementary, cumulative. The study of man, biocenoses, the Earth, global problems is possible only by many different independent sciences, and their integration into something universal is very doubtful. However, polydisciplinarity is not able to provide a holistic vision of the object.

Transdisciplinarity means not just going beyond individual disciplines, but a holistic, holistic vision of the subject of study in all its complexity. If classical science tends to simplify the complex, which gives rise to differentiation and, accordingly, interdisciplinarity, then modern non-classical (post-non-classical) science tries to embrace reality in its complexity and multidimensionality. In real research practice, transdisciplinarity turns into the application of the cognitive strategy of a certain discipline in another science, which is often carried out in joint projects. It is transdisciplinarity that best corresponds to the ideal of unified scientific knowledge. At the same time, it leaves room for a deeper integration of science with various forms of culture. The founders of the transdisciplinary strategy are Jean Piaget, who founded the International Transdisciplinary Center for Genetic Epistemology, as well as Lima de Freitas, Edgar Morin, Basarab Nicolescu, whose signatures as editors are under the Charter of Transdisciplinarity.

5. Foundations of science

5.1. Ideals and norms of science.

The ideals and norms of science express its values into goals. The ideal captures the idea of the perfection of forms, types, organization of knowledge. Norms represent the requirements for knowledge or scientific activity characteristic of a given era.

Ideals and norms are presented in the following forms: evidence, validity of knowledge, its construction and organization, description and explanation. For example, from the point of view of certain scientific and philosophical trends that prevailed in a particular era, knowledge must be substantiated in experience, as empiricism proved, or, on the contrary, in reason, as rationalism believed; organized inductively, as Francis Bacon wanted, or vice versa - deductively, as Rene Descartes believed; the explanation must be teleological, as Aristotle and his followers argued, or causal-mechanistic, as modern science believed.

Ideals and norms differ in levels.

1) The general ideals and norms of science distinguish it from other forms of knowledge. Thus, the validity of knowledge by reference to authority in science is not an ideal, but in religion it is.

2) Ideals and norms of a certain stage, scientific development - the style of scientific thinking of the era. So, for classical science of the XVIII-XIX centuries. the ideal was a uniquely deterministic explanation, and for the science of the 20th century.

- probabilistic-statistical, for example, in quantum mechanics, where it is impossible to uniquely determine the behavior of an electron.

3) Ideals and norms of science in individual disciplines. Thus, in classical mechanics, mechanism arose as an ideal and norm of explanation and description, and in physics at the turn of the nineteenth and twentieth centuries. - energyism as an ideal of explanation due to the special advances in thermodynamics at that time. According to energetism, the last foundation of the world was not mechanical atoms, but energy.

5.2. Scientific picture of the world. Humanitarian picture of the world.

The scientific picture of the world is a synthesis of generalized ideas about the world obtained in various sciences with the predominance of more developed ones. It has a figurative character and functions as a model, predetermining the scientific search, understanding, choice of research tools. So, for the science of the XVII century. the image of a clock mechanism was characteristic, by the type of which the structure of the world was understood, and for science of the late 18th - early 19th centuries. - the image of a wave, a flow, which was associated with the success of hydrodynamics and influenced electrodynamics, optics, etc. Recently, the humanization of the picture of the world has been carried out, when a person as a subject of knowledge is no longer excluded from it.

The picture of the world can be considered as a certain theoretical model of the reality under study. But this is a special model, different from the models that underlie specific theories. They differ in the degree of generality: many theories, including fundamental ones, can be based on the same picture of the world. For example, the mechanics of Newton-Euler, thermodynamics and electrodynamics of Ampère-Weber were associated with the mechanistic picture of the world.

Types of picture of the world. The presence of a general scientific picture of the world implies the existence of particular scientific pictures of the world, "disciplinary ontologies". They are generalized schemes - images of the subject of research, through which the main characteristics of the studied reality are fixed. These images are often called special pictures of the world. The term "world" is used here in a specific sense - as a designation of a certain sphere of reality studied in a given science: "the world of physics", "the world of biology", "the world of psychology" and the like.

Given the textual-discursive nature of humanitarian knowledge, we can talk about a single world of the humanities and a single scientific humanitarian picture of the world, as well as disciplinary humanitarian pictures of the world (the world of literary criticism, the world of regional history, etc.).

Complementary pictures of the world. The emergence of humanitarian pictures of the world, both disciplinary and general, is an inevitable consequence of the development of humanitarian knowledge.

Many objects of science can "turn" either natural science or humanitarian, depending on the applied approaches, paradigms, theories, methods and other means from the arsenal of the natural and human sciences, to one degree or another involved in worldviews. Depending on the goals of the study and the means used, the same objects look like different phenomena. In some cases - as humanized, subjective, individual. In others - as independent, objective, typical. The situation with the complementarity of the objects of scientific activity, as well as of human experience in general, resembles the complementarity of the objects of the microcosm, "acquiring" certain properties depending on the chosen means of description. The principle of complementarity formulated by Niels Bohr in connection with the interpretation of quantum mechanics has a universal methodological significance. In its most general form, this principle requires that “additional” classes of concepts be used to reproduce the integrity of the object under study, which, taken separately, can mutually exclude each other.

Features of the humanitarian picture of the world

1) the general scientific humanitarian picture of the world is relatively independent along with the natural science one. 2) it does not claim the status of the only general scientific picture of the world, does not displace the natural science, but works with it on complementary principles. 3) it is able to perform, in addition to

axiological, also methodological, cognitive, constitutive functions. 4) in the humanities, similarly to natural science, disciplinary pictures of the world function - pictures of the world of the humanities: historical, literary, sociological, psychological.

Humanitarian pictures of the world are fundamentally complementary. In their "cold" version, they distance themselves from the cognizable object and require an objective, subjectless representation of reality. In the "warm" version, having a narrative form of expression, they must take into account the textuality of their object, which essentially depends on the subject.

5.3.Philosophical foundations of science

The philosophical foundations of science are philosophical ideas and principles that substantiate ideals and norms and a picture of the world. So, mathematical natural science could not appear without Descartes' theory of substances, where it found its justification.

The philosophical foundations of science, sometimes directly and directly, sometimes through ideals and norms or the scientific picture of the world, play an important, although not always explicitly expressed role: they regulate and organize scientific activity and its results, closely intertwining with certain philosophical concepts. An example is mechanism, which dominated philosophy and science for a long time.

Scientific activity necessarily includes philosophical principles and provisions, regardless of the desire of the researchers. Moreover, the philosophical presence and influence goes through two channels: inside science and outside. This happens as if by itself without any special effort on the part of scientists or philosophers. But the effectiveness of science, like philosophy, increases substantially when these channels are explored.

Philosophical concepts offered by thinkers are demonstrative, logically developed, non-contradictory theoretical constructions. In this regard, philosophical theory is always exemplary theoretical knowledge. All kinds of theories, including scientific ones, are built on this model. The only difference from a scientific theory is that a philosophical theory is not based on an experimental basis, since this is impossible in principle, otherwise it will not be a philosophical theory at all. It is also important that philosophical theories are never accepted by the philosophical community on faith, without a strict assessment. They are subject to rational discussion and must withstand conceptual criticism, which often results in alternative theories.

In a general sense, we can say that philosophy provides the scientist with basic theoretical and methodological principles.

6. Science in the socio-cultural context.

6.1. Science as a social institution. Scientific communities and the state.

Socio-cultural context of science. Science should be considered in a socio-cultural context because, firstly, it determined the very emergence of science, secondly, it determined those social needs that led to the development of science, thirdly, science began to play more, and over time a decisive role in society, which, in turn, required state and public management of science; fourthly, science, especially modern science, has become not just a cultural phenomenon, but the foundation of modern culture and human civilization.

Science as a social institution. The concept of "social institution" expresses the fact of social fixation of one or another type of human activity. Institutionality involves the formalization of all types of relations of this type and the transition from unorganized activity to the creation of organized structures that imply hierarchy, power regulation and regulations. As a social institution, science includes the following components:

- a set of knowledge that has a certain form of social presentation, and their carriers who have a certain social status;

- specific cognitive goals and objectives, one way or another sanctioned by society;

- certain functions, including social or socially determined ones;

- specific means of cognition, socially regulated;

- special institutions;

- forms of control, examination and evaluation of scientific achievements;

- the hierarchy of scientists;

- regulation and formalization of professional growth;

- certain sanctions.

Institutionality provides social support for those types of scientific activities and those projects that contribute to the development of science for the benefit of society. Scientific practice within the framework of science as a social institution also implies possible restrictions on the freedom of scientific research if, for example, they do not correspond to the ideals of humanism, or pose a threat to society or the security of the state. In this case, the question rests on the adequacy of the corresponding state system, its ideology and policy.

State and science. State-political influence on science is carried out in different directions, but first of all it is the so-called state interest. On the one hand, it has the right to exist, based on the presence of states with different organizations, goals, and interests. But, on the other hand, the state interest may turn out to be contrary to universal norms or simply come into conflict with the general goals, ideals and norms of science.

Such concepts as national science, the prestige of the state, and reliable defense have not lost their meaning. But they essentially depend on the forms of government. In closed societies, secrecy becomes hypertrophied, which harms the state itself and science. In addition, in a closed society of a totalitarian or authoritarian type, the state seeks to completely control science, which negatively affects its development, although certain branches of science can develop very successfully, but not science as a whole. In Soviet times, the problem of the ideological clash between science and power was particularly acute and painful. A number of sciences were declared pseudosciences and persecuted. This negative experience and the positive experience of democratic states show that freedom is important for the development of science, and even government funding of certain projects or fundamental research that do not pay off should be determined primarily by science, and not by the state.

The relationship between science and government can be seen in the examples of involving leading scientists in the process of substantiating important state and administrative decisions. In a number of states, scientists are involved in government, discussing the problems of state structure and state policy. At the same time, science has its own specific goals and objectives, and ways to solve problems, especially in terms of perspective, truth, and so on. Therefore, it is not common for the scientific community as a whole to turn to the authorities or the people as an arbitrator, and the intervention of the state or the people in the process of scientific research is unacceptable for science. At the same time, humanitarian, environmental problems of science must necessarily be under the control of society: the media, public organizations, government agencies.

6.2. Science as a profession.

Scientist profession. In social terms, a scientist is a kind of profession with its own traditions, written and unwritten rules, algorithms, levels, gradations, etc. Like any kind of profession, scientific work and readiness for it requires the fulfillment of some special requirements.

Sociology of science, psychology of scientific creativity, science of science, philosophy and methodology of science and other disciplines have identified a certain set of qualities that allow you to effectively do scientific work:

- Concentration. It involves abstracting from everything that does not relate to the issue under study, hence sometimes absent-mindedness, forgetfulness, and inattention to everyday circumstances result.

- Criticality. This is a special warehouse of scientific thinking that allows you not to take information for granted, to double-check certain results, both others' and your own, to filter out dubious, unreliable data.

- Irregularity. Usually it refers to thinking, but sometimes it spills over into the behavior of scientists, making some scientists extravagant.

– Accuracy, rigor of thinking. Some authors consider this quality to be the most important, since the scientific result largely depends on it. Sometimes this feature goes over to behavior and attitude towards other people, such a person is sometimes called a pedant, cracker, boring.

- The pursuit of truth. True knowledge is incompatible with compromises, which often causes a rather difficult fate for a genuine scientist.

- Rationality. Scientific knowledge requires adherence to standards of rationality. This does not mean that non-rational methods are not involved in any way, but they are all subordinate to the rational form of expressing the results obtained and the ways to it.

Scientists are often referred to as the elite of society, calling the scientific community the intellectual elite, as opposed to the political or artistic elite, or the business elite. All representatives of the intellectual elite are characterized by high productivity in all periods of their activity.

Society one way or another ranks any profession. Scientists are no exception, although there are specifics.

1) there are scientific degrees, titles and corresponding positions with official salaries and additional payments.

2) a system of incentives has been developed: the election of a particular scientist as a full member, corresponding member, honorary member of academies, scientific institutions and societies; awarding prizes and medals for scientific activity; inclusion of biographical information about scientists in special biographical directories and encyclopedias.

3) the degree of explicit and implicit recognition: the participation of scientists in the work of editorial boards, publications with a high scientific index; participation in the work of specialized councils for the defense of dissertations; high citation index of the scientist's publications by members of the world scientific community.

6.3. Ideology and science. Phenomenon of ideologized science.

Ideology and science. Science appears as an instrument of politics. The latter can be carried out through ideology. The history of Soviet science shows how the Marxist ideology totally controlled science, being suspicious of its advanced frontiers developed in the West.

The degree of ideological pressure was felt by science in different ways. The most dependent on ideological influence are always the social sciences and the humanities, the least dependent are usually the natural sciences, but not all. Since Marxist-Leninist philosophy was proclaimed the only true methodology, those theories that posed the question of interconnections and control somewhat differently, like cybernetics, about development and evolution, like genetics, did not take into account the meaningful ideas of dialectical logic, like mathematical logic, or the concepts of historical materialism. as a parametric theory of systems, were subjected to versatile criticism, sometimes accompanied by prohibitions and persecution. Technical sciences, largely limited to applied goals, demand from production and consumption, are at first glance independent. But if the state controls production and distribution, then the applied sciences also become ideologized.

The characteristics of ideology include its deliberate distortion of reality, dogmatism, intolerance, and the absence of refutation mechanisms. Such, in particular, was the Marxist ideology. The tragedy of the Soviet period of our history is a clear demonstration of what can happen when ideology subjugates science.

It is now obvious that the danger of ideology increases many times over in a totalitarian or authoritarian society when it becomes dominant. Its danger is not always felt by individual and mass consciousness due to the numerous myths, especially historical ones, that flourish in such favorable conditions.

A scientific ideology is impossible by definition. Ideology is always an expression of this or that interest, while science must be disinterested, impartial, objective. If science is not objective, it is no longer science. Even if ideology pursues the most beneficent goals, it must be controlled by science, otherwise inadequate, interested interpretations are inevitable, which are sometimes akin to falsifications.

7. Moral norms and values of science.

7.1. Value-normative regulators of science.

Science and morality. Recently, the moral problem of the scientist's responsibility for his discovery has been actively discussed, especially in genetic engineering, biotechnology, and biomedicine. Before scientists there was a real prospect of engineering design of organisms with predetermined properties. A person can construct a new form of life, but he will not be able to return it to non-existence. Do we have a right to this? There are more and more such questions, and in search of answers one cannot do without philosophical and methodological analysis. Thus, a special science, bioethics, arose. The main problem of bioethics has a philosophical and methodological sound: should a scientist be absolutely free in his research or should science be strictly regulated. There are no unequivocal answers, but it is clear that without taking into account the social, moral responsibility of the scientist, the modern development of science is impossible. It is important that moral principles be formulated adequately to humanity and not distorted for use in the fight against objectionable scientists. The very existence of mankind and its future largely depend on the observance of moral norms in science.

The concept of the ethos of science R. Merton. The American scientist Robert Merton (1910-2003) played an important role in the development and study of ethical standards in science. In contrast to the thesis about the value neutrality of science, he revealed those regulators of science that have a value character. Merton's concept was sometimes criticized from various positions, but his main ideas outlived their time and have not lost their significance to this day.

Merton rightly believed that the purpose of science is the production of reliable scientific knowledge. To achieve this goal, it is necessary for the scientist to observe four basic imperatives:

– Universalism, i.e. knowledge is impersonal. The name of the creator is not of fundamental importance for the most scientific knowledge.

– Collectivism, i.e. the need to communicate discoveries to other scientists, for example, through publications, the choice of the necessary data without personal preferences, but on the basis of scientific character.

- Unselfishness, i.e. organization of scientific activity as if there were no interests other than comprehension of the truth.

– Organized skepticism, i.e. exclusion of uncritical acceptance of the results of the study.

In its pure form, the requirements identified by Merton are not so common, but science is driven, basically, by them.

Research work does not always meet ideal ethical requirements. Scientific activity is often regulated by two opposite (ambivalent) factors: the norm and the antinorm. For example: publish a scientific result faster, but carefully check it; perceive new ideas, but not blindly obey the intellectual fashion; to know all previous works, but not to allow erudition to suppress independence.

The ethical norms of science are restrictive: not so much to exclude deviant behavior as to limit it.

7.2. Prohibitions in science. Code of professional ethics of a scientist.

Ethics and deontology. Professional code of honor for a scientist. Within the framework of general ethics, a special area is singled out, called deontology (from gr.

deon - proper, due), the ethics of duty. This term was coined in the 19th century. English philosopher Jeremy Bentham for the name of the theory of moral behavior. In relation to science, the deontology of science can be considered as part of the ethics of science, which studies the ethical aspects of professional activity, in short, what a scientist should and should not do. Proceeding from this, a professional code of honor for a scientist is formed.

– Accuracy, scrupulousness, accuracy of scientific conclusions, calculations, observations, citations.

– Impartiality in evaluating one's own and others' scientific results. This also means the ability to separate ideas from personalities, the ability to accept criticism without offense, to criticize others constructively.

– Respectful attitude towards colleagues, regardless of age, rank, merit.

- Scientific honesty, which prohibits appropriating other people's results, manipulating data, and presenting unreliable material.

A scientist who violates the code of honor loses the respect of colleagues and is considered a dubious professional.

Modern scientific ethics. Scientific activity is subject to a wider system of ethical norms, requirements, prohibitions, written and unwritten rules that determine what is acceptable in science and what is not. In general, they are broader than the ethics of duty and are of a more general nature, complementing the ethics of duty. These include the following prohibitions and requirements.

1. Prohibition of plagiarism. A scientist cannot pass off other people's research or results as his own.

2. Prohibition of falsification, that is, intentional distortion, manipulation of experimental or observational data.

3. The requirement of novelty and validity of the knowledge offered by the scientist.

4. Disinterestedness - the willingness of the scientist to agree with well-founded arguments, even if they contradict his beliefs.

In 2000, the **Senate of the Max Planck Society**, one of the most influential and authoritative scientific communities, developed and adopted the norms of scientific ethics. It is essential that these are not just wishes and recommendations for scientists, but norms that are mandatory for members of society. Proceedings and various punishments are provided for their violation, up to dismissal, deprivation of degrees and the right to teach, criminal prosecution, etc. Many norms repeat those mentioned above, others are adapted to the specifics of work in a given scientific organization. The adoption of the norms of scientific ethics as an official document regulating scientific research in an official scientific organization is evidence that ethics in science is becoming an important factor in successful scientific research.

7.3. Freedom of scientific creativity and social responsibility of scientists.

The problem of freedom, control and expert assessments of research activities. On the one hand, scientific activity by definition presupposes a free intellectual atmosphere. On the other hand, science is involved in the socio-cultural context and cannot be isolated from it. A feature of the current stage of human development is that no sphere of social life can remain outside public control, be it education or production, government agencies or business, healthcare or military affairs, and, of course, science.

Today**, the topic of public control** over free scientific activity no longer causes sharp disputes, thanks also to the scientists themselves, since the discussion of its problems in the socio-cultural, moral and ethical context has become an essential aspect of scientific activity. A significant part of the initiative in this belongs to the scientists themselves. Scientists have created a number of public organizations and movements aimed at maintaining peace, ensuring environmental safety, etc. There are also numerous ethical committees with the direct participation of scientists, various examinations are carried out, in particular, environmental, humanitarian, etc. to evaluate scientific projects and ongoing research. An important result is the almost universal understanding of the importance of the ethical analysis of scientific activity, which resulted, in particular, in certain restrictions on scientific research for ethical reasons. An essential part of the work of ethical committees and other public organizations is to monitor compliance with such restrictions. They relate primarily to social, psychological and biomedical research. So, immoral, therefore, strongly condemned, are studies that violate human rights, infringe on his personal freedom, dignity, and privacy. This also includes experiments related to the misleading of subjects, as well as topics that can infringe on the dignity of a person or make him ashamed in the case of studies of the intimate sphere.

Today, a scientist cannot withdraw into his professional interest, he must be able to consult with the public, explain and argue, substantiate his views, withstand criticism of social and ethical considerations, including those of incompetent people. The practice of scientific research in developed countries demonstrates a very significant fact: scientists themselves actively raise questions about the appropriateness and ethical acceptability of certain projects, participate in the work of various examinations and councils, are able to speak in the media, and also defend their rights in parliament, government, in local authorities.

The problem of the actual evaluation **of research projects also remains acute**. Their comprehensive consideration requires a detailed interdisciplinary approach, the participation of representatives of different fields and not only scientific ones. As a result, in such examinations, there is often a clash of value attitudes and preferences. Therefore, the main issue is the reasonable reconciliation of divergent arguments and opinions. We have to use many criteria and look for reasonable compromises. All this is easier to implement in a society where there are good democratic traditions, a high level of education and professionalism, and moral health.

The problem of responsibility. In any events of modern society, a large number of people are always involved. In a large-scale project, the responsibility of individuals is usually dispersed, and often, when investigating various incidents, it is assigned to non-essential workers. This means that mechanisms should be developed that clearly prescribe who is responsible for what and in what forms. This is both a legal and a moral issue.

In modern conditions, when scientific and technological capacities are so great that their impact can lead to a catastrophe of a regional or global nature, the issue of distribution of responsibility becomes very acute. Perhaps the very doctrine of responsibility should be revised, it is necessary to make a transition from the traditional responsibility of the guilty person for the event to a preventive, protective responsibility. The following point of view is affirmed: the greater the technological capabilities of a leader or actor, the more knowledge is required from him to foresee the likely consequences, and the greater the responsibility for these consequences he must bear.

The problem of responsibility in the conditions of modern scientific and technical and technological capabilities remains controversial. The condition for its successful solution is the openness of scientific and technical projects for public control. Where secrecy and closeness are initially practiced, the ground is created for the permissiveness of some and the constant potential guilt of others, a favorable environment for various abuses and bad faith develops.

8. Ethos of modern science and professionalism.

8.1. Basic ethical problems of science

Topics of ethical discussions in modern science.

1. Purposes and meanings of science. The meanings of scientific activity are inseparable from the goals. Ethically reprehensible are such goals of scientific activity that are obviously inhuman, both in relation to man and in relation to nature.

2. Applied means of research activity. Goals and means are in an ambiguous relationship. But in the modern world, plausible ends must imply corresponding plausible means. The slogan "the end justifies the means" is not applicable to the current realities. In modern biomedical research, a complex ethical dilemma sometimes

arises: experiments associated with the risk to life and health or with the suffering of the subjects can give results that will save many other human lives. Is it possible to sacrifice a few human individuals in the name of the well-being of the many? The answer is unequivocal: no! The general principle for resolving this issue is formulated in the Convention "On Human Rights and Biomedicine", adopted in November 1996 by the Parliamentary Assembly of the Council of Europe. It says directly that the interests and welfare of the individual must prevail over the interests of society and science.

Ethical standards and requirements regarding the means of conducting biomedical research are applicable not only to humans, but also to animals. In 1985, the International Council of Medical Scientific Societies (CIOMS) adopted the "International Recommendations for Biomedical Research Involving Animals", the meaning of which is to minimize the number of animals used in research and the amount of suffering they are subjected to.

There are also moral problems of scientific activity of a somewhat different nature, in which the goals and means of scientific research are inseparable.

For example, **the problem of prioritization of ongoing developments** and their financing, when the question arises of how morally acceptable it is to develop expensive technologies that will bring relief or improve the quality of life to only a small number of people, while the more pressing problems of society remain unresolved. Or a similar problem: how much should be the funding of science in general, given that the funds allocated for the development of science, automatically reduce the cost of social needs. Huge expenditures are known for the creation of experimental equipment for fundamental physics or for space research. Over $6 billion has already been spent on the construction of the Large Hadron Collider (LHC) and experiments. Does humanity have the moral right to spend this money on science with the unresolved problems of hunger and poverty on the planet?

Problems of this kind affect many private and general interests and cannot be assessed in any one plane. When discussing and making decisions, it is necessary to use a set of criteria regarding the importance, relevance, and prospects of research.

3. Consequences of scientific activity. Mankind has not learned to foresee well and calculate the consequences of its actions. However, this cannot be an excuse for the negative consequences of scientific activity, especially given the enormous predictive power of modern science.

A scientist must be responsible for the consequences of his decisions on an equal footing with a politician, administrator, doctor, teacher and, in general, a representative of any profession. This applies primarily to applied research. However, the predictive capabilities of modern fundamental research are also quite large. In our time, science is developing purposefully, theoretical provisions govern empirical search, for example, in physics, theoretical calculations are so perfect that experimental surprises are unlikely. Therefore, the prediction of consequences, including fundamental research, becomes an urgent task.

Ethics of science and practice of knowledge of the XXI century. The variety of ethical problems in a general form is usually divided by modern authors into the ethical problems of physics, biology, genetics, and technology.

Ethical problems in nuclear physics.

In 1938, the splitting of the uranium atom was discovered, which was accompanied by the release of a huge amount of energy. This put on the agenda the issue of practical application and led to a number of ethical problems: is the use, testing, distribution and accumulation of such destructive weapons justified? Is the risk of using nuclear energy for peaceful purposes justified? A serious problem is the storage and processing of nuclear waste. Is the risk of the spread of radioactive contamination justified?

Ethical issues in biology:

– Danger of biologic tendencies. According to the results of scientific research, many negative human traits can be recognized as innate, for example, a tendency to violence, aggression. However, such data, as well as data on innate desire for leadership or education, need to be carefully checked to avoid hasty generalizations and practical decisions.

– The danger of hasty conclusions and generalizations from genetic studies. It is unacceptable to return to pseudoscientific theories of the genetic determination of intelligence that justify racial or gender inequality.

Bioethics. These ethical problems have been formed in research conducted at the intersection of biology and medicine and have direct access to healthcare practice and government programs.

- Attitude towards the patient. Who is the patient in research or treatment: a carrier of a certain disease or a full-fledged personality?

- Impact on humans. Fundamentally new medical technologies and drugs increase the possibility of influencing a person. How does this relate to human freedom and individual rights?

– Danger of destruction of the original biogenetic basis. Various methods of artificial human reproduction, replacement of affected organs and tissues, replacement of damaged genes, active influence on the aging process leads to unpredictable situations, the analysis of which lags behind reality.

– The need for ethical expertise. Commercialization is spreading in almost all areas: the relationship between a doctor and a patient, organ transplantation, the manufacture and sale of medicines, the use of technological innovations in operations and conservative treatments, etc.

– The problem of interference in the human genetic code. Genetic engineering makes it possible to influence the human genetic code and change it. Apparently, this is justified in cases of treatment of hereditary diseases. However, the danger is that organisms participating in genetic experiments may exchange genetic information with other individuals. The results of such interactions can lead to uncontrolled mutations.

Ethical issues of cloning. The rapid development of genetics and successful experiments in cloning mammals raised the question of human cloning.

The outlook for cloning is mixed. On the one hand, obtaining copies of valuable animals and plants, such as elite cows, horses, fur-bearing animals, as well as the conservation of endangered animal species is incredibly promising. The synthesis of animal and vegetable proteins, the production of insulin, etc. can give a huge economic effect. And since preserved DNA can be found in fossil bones, it becomes possible to restore extinct species through cloning.

But, on the other hand, cloning will inevitably lead to the reproduction of freaks, since, as you know, the goal set does not always coincide with the result. In addition, it is not known how the cloned organism will behave in real life, since it is not clear how the genetic program correlates with the real needs of the organism.

The problem of cloning is multifaceted. There are medical, ethical, philosophical, religious, economic, technological, legal and other aspects. They need to be discussed with large-scale experiments, and even more so with practical application, one should not rush.

These problems are evidence that the ethical regulation of science is today a vital necessity, are a condition for the functioning and development of science.

8.2.Professionalism, dilentanism and amateurism in science.

An interesting difference between modern science and classical science lies in its **democratization**, when non-professionals work in science along with professionals. A striking example of the **participation of amateurs in science** is the discovery of the supernova SN1987A. With the help of amateurs, combining observations with large and small telescopes, professionals have established what a triple asteroid looks like in the Main Asteroid Belt. Special projects are organized that use amateur labor for science, for example, in line with the search for possible intelligent signals from space or the study of images of space objects. It is possible that such cooperation between professionals and amateurs can be organized in many disciplines, where it is often the factor of a large amount of empirical material that can be provided by amateurs that is important.

The abundance of non-professionals increases the risk of errors, fraud, falsification. Astronomy, being a rigorous science, has a reliable toolkit for screening out and cutting off "waste rock", without compromising the ideals of scientific character. Here the role of amateurs is limited to empirical material, they are inaccessible to the "theoretical jungle" that requires special, specifically professional training. In the humanities, by contrast, theories are sometimes less complex and more understandable to non-professionals. Therefore, their claims to be theoretical are more tangible here.

There are not so many examples of the successful activity of amateurs in the humanities, although there are much more amateur historians, linguists, and literary critics here than in astronomy. Yes, and not very good professionals more. This is due to many difficult problems, in particular, with the Soviet legacy, when the humanities were preparing not so much for scientific work as for the ideological struggle, with the drop in the level of training of specialists and with the drop in the level of professionalism in the post-Soviet space, including in science. As a result, not all professionals, let alone amateurs, can clearly distinguish between science and non-science. It is no coincidence that it is in the countries of the former USSR that **historical myths, false teachings, especially within the framework of folk history,** patriotic pseudo-history or pseudoscience “New Chronology” spread so easily.

In such cases, the problems of **professionalism, scientific character, and morality** come together. Any person involved in science as a professional or an amateur must have a certain set of professional knowledge and skills, methodological training, ideas about the norms of scientificity, and an appropriate level of morality.

The scientist must be aware of the responsibility for his activities, both for the results and for the concepts, be aware of the possible damage, both physical and intellectual.

9. Philosophical and methodological context of the structure and dynamics of scientific knowledge.

9.1. Philosophy of science about empirical and theoretical knowledge.

The philosophy of science singles out the main structural subdivision of science: empirical and theoretical levels.

The main cognitive tasks of the subject-researcher at the empirical level are the description of phenomena, the collection of scientific facts, their primary generalizations, as well as the verification and confirmation (or refutation) of theoretical systems. Theoretically, the main cognitive task is the essential explanation of the phenomena under study, their conceptual and theoretical generalization and, ideally, the construction of a scientific theory for them.

The clearest difference between the identified two levels of scientific knowledge is manifested in the nature of the results obtained (that is, the forms of scientific knowledge). The main form of knowledge obtained at the empirical level is a scientific fact and a set of empirical generalizations, for example, in the form of empirical laws. Theoretically obtained knowledge is fixed in the form of a scientific problem, scientific hypothesis, theoretical laws, principles and scientific theories, in which the essence of the studied phenomena is revealed. Correspondingly, the methods used in obtaining these forms of knowledge also differ. The main methods used at the empirical level of knowledge are observation, measurement, experiment. Theoretically, methods such as idealization, axiomatic and hypothetical-deductive methods, mathematical modeling, formalization, etc. are used.

The empirical and theoretical levels are relatively independent, for example, theoretical and experimental physics work with their own languages. At the same time, both levels are closely interconnected, the line between them is rather conditional. The theoretical “loading” of empiricism should be especially emphasized. The latter is not independent.

The concepts of "empirical" and "theoretical" should not be confused with the concepts of "sensual" and "rational". The latter relate to knowledge in general. Both sensual and rational are used at both levels of science: at the empirical level, where rational processing of sensory data is needed, and at the theoretical level, where sensory-visual representations are indispensable.

9.2. Forms of fixation and development of scientific knowledge. Philosophical and methodological meaning of scientific laws and concepts

Scientific law is a form of scientific knowledge that expresses the objective connection of phenomena, characterized by regularity, reproducibility (verification and confirmation), and materiality. In the language of science, a scientific law is expressed in the form of a conditional sentence (an implicative statement with a universal quantifier). Scientific laws must be distinguished from legal laws, laws (norms) of morality, as well as laws in the field of religion. Scientific law is one of the most important categories of scientific determinism. Scientific determinism is a kind of determinism; it is a concept according to which the world is an ordered, regular whole, the dynamics of which is described by scientific laws.

Classification of laws. The simplest (although not so definite) division of laws is the division according to the "volume" of their subject area into **private** (for example, Ohm's law) and **general** (for example, the law of conservation and transformation of energy). If we take into account the form of expression of laws, then they can be divided into **qualitative and quantitative**. The former are formulated purely verbally (verbally), while quantitative laws allow a mathematical form of expression through the relationship of quantities.

If we keep in mind the nature of objects and predictions of their "behavior", then the laws are divided into **dynamic** (single objects "submit" to them and their predictions are rigidly unambiguous) and **statistical**, relating to objects that include a huge number of elements, and therefore they give only probabilistic predictions.

If we take into account the nature of objects, then we should distinguish, for example, **natural science** (laws of nature: physical, chemical, geological, biological, etc.) and **social laws**. At the same time, for example, social laws will have to take into account the significant role of the subjective factor, since the social objects that such laws concern are people, individuals who, among other things, have freedom and will.

A scientific concept is a form of thinking that includes a set of features that are necessary and sufficient to indicate or highlight an object (or class of objects).

In traditional logic, the **content and scope of a concept are distinguished**. The content is the semantic side of the concept, it is what is understood by the participants in the speech interaction (discourse) when using this or that concept. For example, a person can list the features that he identified in the object designated by the concept, or at least (this is the minimum requirement) knows how to correctly use this concept in language practice.

The scope of a concept is the actual side of a concept, it is a class of objects characterized by a given concept. Let's say that the scope of the concept "table" includes all the tables that actually exist.

The simple “volume/content” scheme, which works well for everyday concepts, does not fully correspond to the specifics of scientific knowledge, because due to the highly abstract nature of scientific concepts, it can be quite difficult to indicate those real objects that should correspond to one or another concept.

The traditional operations performed on concepts include **definition of the concept and logical division**, which consists of dividing the scope of the concept into smaller units based on some additional attribute. The most common separation option is the classification operation.

Since the concept fixes certain knowledge in itself, the content of the concept, as a rule, can be expanded into a certain set of judgments. For example, the scientific concept of "gene" already implies some concept of what a gene is.

Formation and functioning of scientific concepts. Scientific concepts often come to science from everyday life (as, for example, in physics: force, work, etc.). However, in a scientific context, they acquire a specific meaning and refined content. In science, when forming a concept, they try to fix the most essential, important properties, relationships and regular connections of the object under study.

In the natural sciences, the formation of a concept is subject to the most important requirement of operationalization. **The operationalization** of a concept consists in clarifying and clarifying how it is possible to operate with a given concept and the essence that this concept allows: to check its presence, to measure or determine its gradations and degrees, to find out its relationship with other entities. The general tendency of natural science is to get rid of non-operationalized, that is, inefficient, concepts. In a number of humanitarian disciplines, especially those that claim to be scientific, the requirement of operationalization is also mandatory.

The formation of scientific concepts should not be thought of only as a process of fixing something known. Often the **concept acts as a research tool**. In this case, concepts are introduced as names of supposed objects, and the question of the existence of these objects and their possible properties becomes another scientific problem.

9.3. Forms of development of scientific knowledge. Scientific fact, problem, hypothesis, theory. Their philosophical and methodological meaning.

The most important forms of knowledge organization (and at the same time its development) are scientific fact, problem, hypothesis, theory.

Observation protocols and empirical facts. Observation data contain primary information in the form of observation protocols. Observation protocols usually contain indications of who carries out the observation, and if the observation is built during the experiment using any instruments, then the main characteristics of the instrument are given. Objective information can be distorted by random external influences, various instrument errors, observer errors, etc. Therefore, observational data is not yet reliable knowledge, and the theory cannot rely on them. The basis of the theory is not observational data, but **empirical facts**. Unlike observational data, facts are always reliable and objective information, free from errors and random deviations.

Establishing an empirical fact requires the application of a number of theoretical propositions, but then a difficult problem arises, which is that in order to establish a fact, theories are needed, which must be confirmed by facts. This is the problem of theoretical loading of facts.

A problem is a form of knowledge organized as a set of questions for which there is not enough knowledge to answer. Therefore, the problem is called knowledge about ignorance. To solve a problem, new knowledge must be created. In this respect, the problem differs from a scientific problem, for which the existing knowledge is sufficient. The entire course of the development of science can be represented as a transition from the formulation of problems to their solution, and then to a new formulation of other problems arising from the solution of the previous ones.

A hypothesis is an assumption formulated to solve a problem, consisting of unproven and directly unverifiable statements, from which verifiable consequences are derived to compare them with facts.

Stages of hypothesis development:

1. Generalization of facts, therefore a hypothesis is called a form of understanding the factual material.

2. Derivation from a hypothesis of consequences, which are usually laws, therefore a hypothesis is called a form of transition from facts to laws.

3. Comparison of consequences with facts, i.e. hypothesis testing, after which the hypothesis is rejected or accepted.

A hypothesis must meet a number of requirements: it must cover as many facts as possible, be simple, be fundamentally verifiable, since hypotheses that cannot be verified do not make sense in science, and must predict new facts. The principle of simplicity, for example, means that among competing hypotheses, preference is given to the simpler hypothesis.

Theory is a system of confirmed knowledge that explains and predicts a certain set of phenomena.

Theory structure:

1. Initial foundations: principles, postulates, axioms without which the organization of knowledge included in the theory is impossible.

2. Idealized objects of this theory, for example, an absolutely solid body” or “ideal gas” in physical or chemical theories.

3. Logic, according to the rules of which some statements are derived from others. It can be the logic of an ordinary language or a special logical-mathematical apparatus.

4. A set of laws and statements, as well as special concepts - the language of theory, for example, "charge", "current", "field" in physics, which have a special meaning.

5.Philosophical attitudes and value factors, often implicitly present in the theory, for example, the mechanical or expedient arrangement of the world.

6.Empirical basis - a set of factors on which the theory is built.

The difference between a hypothesis and a theory in terms of methodology is relative and is determined by the degree of confirmation and development of the hypothesis.

theory requirements.

1. The theory must have a scope where it successfully explains the facts. The boundary of this sphere is usually defined by more general theories.

2. Theory should have the scope of predicting unknown phenomena, which makes it possible to develop the theory. In particular, the narrowing of the sphere of prediction testifies to the unfavorable theory.

3. The theory must be formally consistent, otherwise it will be possible to prove anything in it. The requirement of consistency is an incentive to improve the theory.

Scientific theory occupies a special place in science. It is the end of scientific research. Scientists want the theory to be perfect. However, this does not happen, although at first it seems that the ideal has been achieved. Taking into account this situation, Karl Popper formulated **the principle of fallibilism** (from the English fallibility), which requires the recognition of error, the imperfection of any knowledge. The claims of any theory to infallibility testify to its belonging not to science, but to ideology.

9.4. Philosophical and methodological features of theories. Scientific, technical and humanitarian theories.

Theories can be classified on various grounds. There are undeveloped theories in which empirical generalizations predominate: the Darwinian theory of natural selection, the Pavlovian theory of conditioned reflexes, and developed theories, including theoretical laws, idealized objects, a special inference apparatus, etc. From undeveloped theories one should distinguish empirical and descriptive ones, which are fundamentally oriented towards empirical material: taxonomic, paleontological, archaeological.

Hypothetical-deductive theories are singled out as an ideal of the logical organization of natural science knowledge. This is a concretization of the concept of axiomatic theory. Striving for this ideal makes it possible to make the theory stricter and more confirmed.

Scientific and technical theory. Its specificity: to reveal the internal correlation between the characteristics of the structure and functioning of a technical object. This relationship is due to natural processes. Hence, there are three types of characteristics: morphological (structural characteristics), functional (technical) and natural (natural).

Technical theory arises: 1. As a generalization of the structure and functioning of production, in particular, the physical nature and design features of technical devices. 2.As a practical application of the natural sciences. Z. How to master the technical side of cognitive activity, the creation of measuring instruments, instruments, etc.

The main function of technical theory is not explanatory, but constructive-technological. A feature is also not predictive power, but technological capabilities. In addition, the object of technical theory is the result of social activity, and not purely natural as in natural science.

4. The semantic completeness of the theory is desirable, i.e. every true proposition in it must be provable. True, the Austrian logician K. Gödel (1906-1978) proved that some meaningful true statements of theories are not provable in it, however, the requirement of completeness leads to the search and discovery of such statements and to their justification in other ways.

When creating a technical theory, special principles are required:

I. the principle of action, which determines the range of theories and the way they are combined into a new field of knowledge, the object of which will be the future construction.

2. The principle of consistency, which allows different ways to consider the problem.

3. the principle of practical relevance, since momentary needs come to the fore.

4. the principle of manufacturability as the identification of phased processes for creating an object.

5. the principle of reliability as a determination of the degree of durability of an object.

Humanitarian theories. Humanitarian theories should contain standard components, which are enough to classify them as scientific: initial principles, idealized objects, a set of laws and concepts, the scope of technological implementations, object and subject, classifications.

Differences between theories are manifested in the specifics of the components, especially laws or other explanatory provisions, or system-forming concepts. **Theories of the first** type include laws, including those from other sciences, rules and norms that act as laws, as well as narratives that either include laws or can be transformed into laws. **Theories of the second type** use narratives, metanarratives, tendencies, linguistic figures, linguistic structures.

Subject and object of humanitarian theory. In the methodology of science, the object and subject of the theory are distinguished. At present, this interpretation is generally accepted. The object is both a material and an ideal phenomenon, for example, the theory itself or the concept, or the inner world, feelings and thoughts, say, of the author of a literary work or natural science theory, to be studied. The object is what is constructed by theoretical means.

The difference between a humanitarian subject and a humanitarian object is that the former is constructed by the corresponding theory, while the latter is constructed by various theories, concepts, discourses and, as a rule, appears earlier than the former. Therefore, the truth of a humanitarian description - historical, psychological, literary as a correspondence to an object - cannot be spoken of in the same sense as in the natural sciences. On the other hand, we can talk about the adequacy of the interpretation within the framework of the relevant context, value system, theory, etc. In this sense, not only the subject as an aspect of the object is created by humanitarian theory, but the object itself as a historical, psychological, literary reality.

10. Philosophical and methodological specificity of scientific knowledge.

10.1. scientific knowledge. Scientific, technical and humanitarian knowledge. The problem of demarcation of scientific and non-scientific knowledge.

Features and structure of scientific knowledge. The term "knowledge" is used in a narrow and broad sense. In the broad sense of the word, knowledge is considered as some content of consciousness that can be described in any way. In this case, various views, beliefs, intuitions, prejudices, personal knowledge fall into the category of knowledge.

Knowledge in the narrow sense should have the main features: validity, explicitness, general validity, referentiality, valence (for example, true or false), reflexivity. All of these features are interrelated, for example, without explicitness or general validity (intersubjectivity), validity is impossible, since knowledge must be somehow represented. Only the fulfillment of all signs (conjunction) gives what in the strict sense is called scientific knowledge.

Often, the following features are also distinguished: 1 Reproducibility, that is, the possibility of repeating a scientific result under appropriate conditions; 2. Testability, that is, the availability of knowledge to various methods of verification; 3. Derivability as the possibility of obtaining non-obvious consequences; 4. Consistency, presented, for example, in theory; 5. Predictability as an opportunity to foresee the onset of certain events, etc. Some of them are the result of the above features of scientific knowledge, although in some cases they have independent value.

Along with the explicit, science includes **implicit knowledge**: hidden prerequisites for research, implicit meanings of theories, language means, structures of certain actions and skills. The task of the methodology of science is to make them explicit. A special place is occupied by personal and background knowledge, which largely determines the research process, but only partially enters into the formulation of the result. The concept of personal knowledge was put forward in the 50s. XX century Michael Polanyi (1891-1976), English physicist, chemist and philosopher.

Scientific and technical - a special kind of knowledge, sometimes called design and technological (some authors consider the latter to be an independent type of knowledge), which has the following features:

1. Is a normative prescription for activity, usually acts as a technological recipe. This is the knowledge of "how" in contrast to the knowledge of "what", which is characteristic of natural science.

2. Involves a description of the objects of activity - devices, mechanisms.

3. It is a variety of theoretical schemes that provide solutions to many specific situational problems.

4. It is repelled from the diverse theoretical constructions related to one and. the same object and a wide range of methods of applied mathematics. Through simplifications, approximations, transformations, subject to the intended result as a goal, something new arises that gives reason to attribute the acquired knowledge to scientific knowledge.

5. Cognitive installation in technical knowledge is subject to design. The formula works here: to know in order to do.

6. Often, within the framework of technical knowledge, purely methodological problems are solved.

Humanitarian knowledge is knowledge about the inner world of a person, which is expressed in some way in language, human relations, material objects, where sociocultural meaning is fixed, i.e. it covers the space of human meanings, values, meanings that arise during the creation and assimilation of culture. Since humanitarian knowledge does not describe nature, technology, society, they are presented in it not naturalistically, not materially, but in a value-spiritual-semantic way, which requires, first of all, understanding, interpretation. In this regard, any natural object involved in socio-cultural activity is endowed with a value-semantic essence and acquires a humanitarian dimension, which can become the subject of study for humanists.

Humanitarian knowledge uses specific concepts: understanding, discourse, text, narrative, etc., many of which have become general scientific.

Technical and humanitarian types of knowledge are closely related and sometimes it is impossible to draw a dividing line. Their interrelation increases with the development of technology and new technologies. The current technological situation in many ways forces us to take a different look at the traditional approach to the relationship between technology and art. The very understanding of art is undergoing changes due to the fact that new technologies, from photography and cinema to modern computer graphics, dictate new conditions for considering such a relationship.

Scientific and non-scientific knowledge. Extra-scientific knowledge is knowledge that is beyond the bounds of science. Some authors (V.P. Filatov) distinguish three types of extra-scientific knowledge: paranormal, pseudo-scientific and deviant. **The paranormal** (from the Greek raga - about, at) includes teachings about secret natural and mental forces and relationships that are hidden behind ordinary phenomena. This is the area of mystical teachings, spiritualism, where, surrendering to mystical contemplation as the highest cognitive ability, one can, as it seems to the adepts, penetrate into the mysterious connections of the world. Supporters of **pseudosciences** (false teachings) emphasize their desire to use the scientific method, but their activities are carried out beyond the bounds of normal science, such as ufology or astrology. **Deviant** knowledge goes beyond the paradigms accepted at one time or another in science and deviates from the existing methodological and worldview norms and standards shared by the majority of members of the scientific community. Deviant directions may end up in the creation of a recognized scientific program, or the extinction of such a direction, which rests on the conviction of its creators.

10.2. The concept of truth in science. The concept of truth and its criterion.

The problem of truth. The truth characteristic (sometimes called the valence of knowledge) of a scientific statement is its property to be true or false.

The problem of defining truth. There is a classical definition of truth, which was formulated in antiquity: true knowledge is that which corresponds to reality. On the basis of such an understanding of truth, the **correspondent concept of truth was built** (from the Latin correspondere - “correspond”). The correspondence conception of truth seems convincing because it corresponds to our intuitions about truth, but its modern understanding is ambiguous. The difficulty lies in the very concept of "reality", and, strictly speaking, we never apply knowledge to reality itself, but compare some statements with other statements, accepting some of them and rejecting others.

Coherent theory of truth (lat. cohaere - "to be connected, linked"). In accordance with it, the true knowledge is those that are consistent with each other within a certain theory and can be tested for other properties: consistency, coherence, validity. The coherent concept of truth has its merits: it does not require going beyond the theory, since the comparison of some statements with others takes place within the theory, and, moreover, it is more in line with the realities of scientific research, especially in logic and mathematics or in mathematical disciplines.

Eliminative (from Latin eliminare - “to expel”) concept. Its supporter is the modern philosopher Bastian van Fraassen. Fraasen believes that science strives not for truth, but for the creation of theoretical constructions that would be adequate to empirical evidence. But with this approach, the age-old difficulty remains: how to establish this adequacy? Each scientist may have his own options, and then he will have to appeal to the scientific community, which will accept or reject this knowledge on the basis of some convention. This is how the **conventionalist** (lat. conventio - “agreement”) concept of truth arose, which can be considered as a variant of the elimination concept. Such a concept is convenient, but it does not solve the difficulties of conceptions of truth.

Pragmatic concept. This concept of truth goes back to pragmatism, as a direction of American philosophy, associated with the names of Charles Pierce, John Dewey, William James. The pragmatist concept implies non-theoretical criteria: practical usefulness, efficiency. In some disciplines, especially science and technology, this criterion works. However, in general terms, such a criterion is unconvincing, since the validity or usefulness of a theory in practice is still no guarantee of its truth. For example, the famous physician of the XVI century. Paracelsus successfully used iron salts for the treatment of anemia, but the theory from which he proceeded has long been recognized as untenable.

The problem of criteria of truth. In scientific knowledge, one criterion is not universally applied, but rather a large and heterogeneous set of them is used: the criterion of logical consistency, the internal consistency of the provisions of the theory among themselves on the basis of some substantive provisions and conceptual relationships, the general coherence of the theory, the requirement of agreement with the facts, with experience data.

In evaluating a particular theory, **fundamental ontological ideas** about the structure of matter, about the main essences of the world, are often used, which significantly affect scientists' ideas about what is true and what is not. For example, scientists at the end of the 19th century tried to reduce descriptions of electromagnetic phenomena to atomistic ideas, since the atom was considered the fundamental basis of matter, and without this the electromagnetic theory could not be accepted as true.

Evaluation criteria play an important role in accepting scientific theories as true. These include a sense of the "beauty" of the theory, its **harmony, perfection, simplicity**. Thus, Einstein spoke of the internal perfection of a theory as the most important criterion for its truth.

The famous German philosopher Karl-Otto Apel (1922-2017) proposed a variant of the conventionalist concept, which has gained popularity in modern philosophical and methodological literature. He suggests that the criterion of truth is not the actual consent of the scientific community, which may turn out to be erroneous, but idealized. If a scientific theory can be accepted in an ideal unrestricted communicative community, then it is true.

The question of the universality of the applied criteria, as a rule, is raised infrequently, namely when a particular study or its result acquires a clear philosophical and methodological sound. But the scientist must know in what cases such a formulation of the question is necessary and which criterion is preferable in a given situation.

10.3. The problem of substantiation of scientific knowledge. Empiricism, rationalism, Marxism, pragmatism.

The main problem of distinguishing knowledge from belief or opinion is the question of the justification of knowledge. Some thinkers believed that it was doubtful that this question had any positive or negative answer. This is how philosophical **skepticism** developed. Even ancient skeptics, such as Pyrrho, who lived in the IV-III century. BC, they noticed that if knowledge requires justification, then after all, this foundation also requires its justification, and so on ad infinitum.

The famous modern skeptic David Hume (18th century) argued that scientific predictions are not the result of laws, but of habit based on our belief in the immutability of the laws of nature.

When empirical natural science was taking shape, it seemed convincing to many to substantiate knowledge in sensory experience. This is how **sensationalism** (from Latin sensus - feeling) developed, which considered feelings to be the only reliable source of our knowledge. The essence of sensationalism was quite accurately expressed by John Locke (XVII century): “there is nothing in the mind that was not previously in the senses”, at our birth the mind is a tabula rasa (blank slate). Similar to sensationalism is empiricism, which believed that the entire content of our knowledge is exhausted by sensory experience, and the mind only connects sensory data. This position has its advantages, because it frees knowledge from fantasies, imaginary and non-existent properties, and so on.

However, for those scientists who were engaged in mathematics, such a position was unacceptable, since it was completely obvious to them that many truths of science were produced by the mind without any recourse to feelings and experience. This concerns, for example, the creation of differential and integral calculus. This is how philosophical **rationalism** (from Latin ratio - reason) developed.

The great German philosopher Immanuel Kant (1724-1804) carried out a kind of synthesis of sensationalism (empiricism) and rationalism, based on a transcendental understanding of knowledge, when not objects or their experimental comprehension are considered, but a way of knowing objects, moreover, before experience (a priori). Kant believed that, while cognizing any object, we impose on the results of cognition and its very course, our own cognitive means, primarily the specifics of the sense organs and the features of our concepts through which the object is understood, and what the object itself is, in principle, we do not know. Can. For this, Kant coined the rather precise term “thing in itself”, which is unknowable. This position is called **agnosticism**. Kantian agnosticism, as the impossibility of achieving reliable knowledge and substantiating it, in a certain sense reflects the real numerous difficulties of scientific knowledge and correctly grasps many of its moments. But many believed in the omnipotence of reason and criticized Kant. Only now do we understand that the omnipotence of reason is a delusion that Kant understood long ago, although he could not foresee where uncontrolled rationality would lead.

Criticism of agnosticism was undertaken by many philosophers, in particular Hegel and Marx, who used a number of Hegelian ideas, but gave them a materialistic meaning. Marxism tried to find a justification for knowledge not in the cognitive process, but outside it, declaring materialistic social practice as such a universal foundation: practice is the entire infinite cumulative experience of mankind in transforming the world. In a philosophical sense, on the one hand, this is a good move, since such a universal basis has been found, but, on the other hand, it is highly controversial, since practice is outside of knowledge. In any case, the Marxist understanding of practice cannot be reduced, as not very educated people do, to ordinary experience or even to experiment, i.e. the Marxist understanding of practice does nothing to substantiate a concrete theory.

The one-sidedness of empiricism and agnosticism was attempted to be overcome within the framework of the third path - American pragmatism. As a justification for the truth of knowledge, he referred to individual success in a particular case. However, it is known that false concepts can also bring success. For example, the geocentric system has been successfully used by navigators. Nevertheless, in the technical sciences, practical success is a good criterion for the validity of knowledge.

These concepts and the controversy around them contributed to the understanding of the essence and principles of science in general and scientific knowledge in particular, contributing to the clarification of the basic principles of scientific character. As a result, for example, it became clear that the forms of substantiation of knowledge may differ depending on the nature of the knowledge itself. Empirical methods of justification work well in natural science, rational ones in logical and mathematical knowledge, pragmatic ones in scientific and technical knowledge.

11.Philosophical aspects of method and methodology.

11.1. The concept of the method. scientific method. Classification of methods.

Method (Greek methodos) - in the broadest sense of the word - "the path to something", i.e. any kind of human activity.

The scientific method is a method of activity that includes certain means for obtaining scientific knowledge. The content of the method is scientific theory. A theory can give several methods, and vice versa, a method can be a consequence of several theories. The effectiveness of this or that method is determined by the content, depth, and development of the theory. In turn, the method is used for the further development of science, deepening theoretical knowledge. The theory or the laws, concepts, models, etc. extracted from it do not yet constitute a method. To fulfill a methodological function, they must be transformed from descriptive and explanatory statements into orientational statements, regulative principles, requirements, sequences, and so on.

Classification of methods. Methods are classified on various grounds:

- based on the subject (object) of this science: physical, chemical, biological, sociological, psychological;

- based on the level of science: empirical, for example, observation, and theoretical, for example, formalization;

- based on the degree of generality: general, for example, analysis, and particular, for example, spectral analysis;

- based on the specifics of the means used: qualitative, quantitative;

- Based on the tasks: research methods and methods for constructing theories.

The classification of methods according to the degree of generality and breadth of application is quite common.

1. Philosophical methods. Any philosophical concept has a methodological function, is a kind of way (method) of thinking. For example, the analytical method is typical for modern analytical philosophy, intuitive for the philosophy of intuitionism, phenomenological for philosophical phenomenology, hermeneutical for philosophical hermeneutics, etc. Often philosophical systems and their methods were combined with each other. Thus, Hegel's dialectical method was combined with idealism; Marx's dialectical method was combined with materialism. Gadamer combined hermeneutics with rationalistic dialectics. These are examples of the application of philosophical methods to obtain a philosophical result.

In addition, philosophical methods work in scientific research. But here philosophical methods are not a rigid sequence of actions, but are a “soft” version of mental techniques. They set the general guidelines for research, they cannot replace special methods, and they do not determine the final result of scientific research. The more general the method of scientific cognition, the more uncertain it is in relation to prescribing specific steps of cognition, the greater its ambiguity in determining the final results of the study. Therefore, when materialist dialectics was applied with the "light" hand of Isaac Present in Lysenko's biology, and even with the support of the party leadership, this resulted in both personal tragedies and the tragedy of science itself. This is a typical example of an illiterate attitude towards philosophy as a universal master key.

2. General scientific research methods are used in almost all sciences. These can be mental procedures: analysis, synthesis, idealization, induction, deduction, abstraction, etc., which become methods if they participate in research, and not just in thinking. It also includes methods of such theories that are applied in various disciplines, for example, methods of general systems theory or synergetics. Their concepts play a methodological role. For example, system-forming concepts: concept, structure, system, element, optimality, etc. Or the concepts of synergetics: order, chaos, non-linearity, uncertainty, instability, dissipative structures, bifurcation, whole, randomness.

3. Private scientific methods are used in individual sciences. These are the methods of mechanics, physics, chemistry, biology, sociology, linguistics and others.

11.2. The concept of methodology. Levels of methodological analysis. Methodological concepts.

The term **"methodology"** is used in several meanings (not mutually exclusive).

1. A set of means, methods used in any activity. In this sense, any activity has a methodology, and even ordinary theory also includes a certain methodology.

2. The doctrine of the regulators of activity. As a rule, this is a philosophical methodology based on certain philosophical principles.

3. An area of knowledge that specifically studies the means, prerequisites, principles of any type of activity, and if we are talking about science, then the methodology of science deals mainly with the study of methods and principles of scientific research.

Traditionally, the problems of methodology were developed by philosophy, within which methodology was intertwined with the theory of knowledge. In connection with the development of science and the process of its self-consciousness, a special system of knowledge arose - the methodology of science.

The methodology of science, in contrast to the methodology that offers a description of the sequence of specific actions and procedures, studies the laws and regulations of mental activity in scientific research. Both the methods and the foundations of science act as such regulators, in connection with which scientific procedures, the laws of the development of scientific knowledge, and the scientific language, etc., fall into the scope of the methodology of science.

Levels of methodology of science.

1. Philosophical and methodological, where the initial philosophical and value orientations of the scientist, the meaning of scientific activity, the scientific picture of the world are studied.

2. General scientific level, at which general scientific premises, thinking style, ideals and norms of science are studied.

3. The level of special scientific methodological knowledge, which generalizes samples of the study of particular scientific and technical problems, criteria for selecting theories for engineering implementation, features of special scientific creativity.

Philosophical means of analysis can be present at all levels of the methodology of science.

Methodological concepts. Methodological concepts, in addition to the method itself, also include: approach, program, algorithm, regulatory principle, methodological principle.

A program is a set of research tasks and ways to implement them. The program is a fairly broad concept and does not imply a detailed specification and unambiguous result, but it has a clearly defined goal, which usually unites a wide range of participants. In a narrow sense, a program is a well-defined sequence of operations, such as a computer program.

An algorithm is a clear and unambiguous sequence of actions that inevitably leads to the solution of a particular problem. The method in the general case, unlike the algorithm, does not imply an unambiguous sequence of actions and does not always guarantee the achievement of the goal.

An approach is a more general concept than a method. The approach is based on a certain idea, includes certain theoretical assumptions, including ontological ones, that go beyond the object of study and the method itself. The approach acts as a theoretical basis for more specific methodological prescriptions. Within one approach, a whole set of methods can be used. The concept of "approach" is often used in situations where a particular subject area of science has not yet been methodologically formed.

The regulatory principles of scientific knowledge are the norms of cognitive activity in science, more or less defined. An example is the principle of simplicity, the principle of aesthetic perfection, the principle of harmony, etc. The term "regulative principle of scientific knowledge" is also used in a broader sense, characterizing, generally speaking, any norms of cognitive activity in science.

A methodological principle is a certain form of cognitive activity in science, and more explicit than the usual regulatory principles of scientific knowledge. Most of the methodological principles that work effectively in science have been formed in physics and mathematics.

11.3. The problem of method in the humanities.

According to supporters of a unified methodology, humanitarian knowledge is associated with general scientific methods, the presence of which is evidence of the scientific nature of knowledge. However, many prominent authors associate the humanities with special methods, for example, "understanding." F. Schleiermacher pointed out the need for consonance of the state of the researcher with the inner world of another person. V. Dilthey especially emphasized the role of “transferring oneself into the place of another”, **empathy**, empathy, giving the interpretation a clear psychological connotation. And although "methods" like empathy are more evidence of the art of the researcher than contain an ordered set of sequential steps, nevertheless, the appropriate level of knowledge provides the opportunity for a special "accustoming" to a different culture. This means a kind of mindset and feelings, when the researcher understands what exactly the person of the studied culture knows, sees and feels. **Getting used** to a foreign culture cannot be called a strict method of research, especially since it is impossible in its pure form, because it is impossible to move to another time, to forget about one's own culture in which the researcher lives and works. In addition, it is not quite clear how the subjective feeling of empathy and empathy can be translated into an intersubjective sequence of actions that make up the method in the strict sense.

Another way of research, which is inherent in humanitarian research, is often called **the dialogue of cultures**. MM Bakhtin emphasized that a foreign culture reveals itself more fully and deeper only in the eyes of another culture. One meaning reveals its depths, meeting and touching another, alien meaning; a kind of dialogue begins between them, which overcomes the isolation and one-sidedness of the meanings of these cultures. Such a dialogue requires the study of the language of a different culture, the forms of human behavior, the meaning of their symbols, that is, a high level of knowledge, the acquisition of which requires a considerable number of various methods.

Methods of "getting accustomed" to a different culture, the dialogue of cultures cannot be called strict scientific methods, since they do not indicate that generally significant sequence of steps that would give a result. They are close to art, so they can be called scientific methods only in a broad sense. They are used by theories with non-strict requirements for the method, for the formulation of laws, limited to narratives, philosophical metanarratives, linguistic figures, etc.

Hermeneutic procedures look more rigorous, especially in attempts to develop a specific methodology for understanding, for example, in sociology, psychology, anthropology. Criteria for the validity of hermeneutic procedures, principles of adequate interpretation, etc. are being developed. Emilio Betti, for example, in his polemic with Gadamer tries, in contrast to philosophical hermeneutics, to give "methodological" hermeneutics the features of a strictly working method. He formulates special canons. Among them: the requirement that the reconstruction of the text correspond to the point of view of the author and the related requirement for the autonomy of the text as having its own logic; the need to introduce the principle of the so-called hermeneutic circle into the research method, and others.

Other authors focused on approaches related to the individuality of the objects of the humanities. This is how the concept of **individualizing methods** was born, in particular in history (Rikkert) and ideographic methods (Windelband), where the term “method” essentially means an approach or a set of requirements.

A special group of methods are **structural-semiotic methods**, which claim to be a scientific explanation of the text as a sign system organized in a certain way. The attractiveness of such a methodological approach brings to life attempts to bring together hermeneutic and structural-semiotic analysis (P. Ricoeur). Structural-semiotic methods are close to a strict understanding of the method and, together with the methods of linguistic analysis (the method of synchronous cuts, distributive and transformational analysis, etc.), on the whole, correspond to the classical requirements. They allow the corresponding theories to be considered strictly scientific, almost indistinguishable from the natural sciences, especially if mathematical methods are applied there.

At one time, great hopes were associated **with mathematical methods** for the scientization of the humanities. For example, in the 20th century, linguists realized that language could be learned by mathematical means. The result was mathematical linguistics. At the same time, it turned out that the mathematical apparatus is applicable only to stable structures of the language, and far from all of them are stable, due to which the language evolves. Apparently, mathematical methods are not applicable to such evolutionary processes. To describe the evolutions inherent in the language, other, perhaps not mathematical, means are needed. But it is precisely a clear understanding of the role of mathematical models, and in general the striving for the classical ideal of theory, that would make it possible to clearly delimit the "fantastic" from the "mathematical" in the language and to find those areas where other methods are needed.

12.Philosophical and methodological problems of rationalism and creativity.

12.1.Philosophical and methodological problems of scientific creativity.

Scientific creativity. The theory of scientific creativity is part of the methodology of science, where the facts and circumstances of creating hypotheses, theories, and new methods are studied. Many of the difficulties here are due to the unconsciousness and randomness of most creative acts.

The results of scientific creativity are sometimes divided into discoveries and inventions. More often, however, any result of scientific creativity is considered a discovery, then they distinguish: what-discoveries (discovery of spots on the Sun, satellites of Jupiter) and why-discoveries (Newton explains the motion of the planets).

On the basis of the Kuhnian model of science, one sometimes distinguishes between revolutionary discoveries (discovery of the quantum), which lead to the creation of a new paradigm, and conservative discoveries that develop this paradigm (discovery of Neptune).

Many researchers of scientific creativity (Whewell, Reichenbach, Popper) believe that creativity is an intuitive act, interesting from the point of view of psychology, and the methodology of science, its logic, history can do little to help, since the specificity of the new lies in the fact that it is not deduced from the old, and only in hindsight can the desired connection be established.

Nevertheless, for a certain class of creative tasks, there is a formal theory of creativity: heuristic programming, heuristics, the logic of scientific discovery, i.e. useful rules based on experience, techniques that limit the search for solutions, but do not guarantee the optimal result.

The theory of creativity proceeds from the assumption that scientific creativity is a choice from a fixed set of possibilities. This is a simplification, but often quite justified. Research on creativity at the intersection of the methodology of science and the psychology of scientific creativity is effective, when various abilities, age characteristics, professional training, cultural and historical conditions are taken into account and they are associated with a certain methodological model. It is shown that in normal science, the originality of the mind rather interferes with the scientist, and during the period of scientific revolutions, sometimes scientists are hindered by their encyclopedic education.

Specifics of scientific and technical creativity:

1. Great proximity to the needs of production, which is the goal of creativity, in contrast to fundamental science, where scientific creativity is not oriented towards production (at least not directly).

2. The relative fragility of creative products, especially in connection with the acceleration of the pace of scientific, technical and technological progress.

3. A more noticeable continuity of the results of creativity, while this is rare for big science, and not typical for revolutionary science at all.

4. The simultaneity of creative results, which acquires an almost regular character not only due to the filiation of ideas, but also due to similar methods, technologies, etc.

5. Less dependence on the abilities of the researcher due to the greater manufacturability of the process of technical creativity.

6. More pronounced collectivism in creative activity, manifested both in the number of participants in creative groups, and in the depth of the division of labor between them.

7.Special criteria for the value of a scientific result: economy, sustainability, reliability, and others.

12.2. Rationality as a philosophical and methodological problem.

The concept of rationality. Rationality (from Latin ratio - mind) is the key term of philosophy in general and the methodology of science in particular, in a simplified form meaning the reasonableness of being, action, relationship, purpose, etc. Classical rationalism developed a paradigm coming from antiquity. It is based on the belief in the absoluteness and immutability of the laws of the Universal Mind, comprehended by man and inherent in everything that exists, including human spiritual ability. The most obvious laws of this kind are the laws of logic, which, according to, for example, Aristotle, are the fundamental principles of being and thinking. Therefore, it is sometimes believed that everything that corresponds to the laws of logic is rational, that which does not correspond to these laws is irrational, that which contradicts logic is irrational.

But the reasonableness of objects, reasonings or actions can be determined by expediency, efficiency, harmony, systematicity, explainability, predictability, etc. Therefore, human activity is considered rational if it meets certain criteria that are historically and culturally determined. Hence the distinction between the rationality of ancient, medieval, modern times, non-classical and post-non-classical rationality as its historical types. From here comes the distinction between rational and rational rationality (as the distinction between reason and reason, for example, by I. Kant). Reasonable rationality includes fairly strict criteria: the laws of logic and mathematics, rules and patterns of action, causal explanation schemes, fundamental scientific laws, systematicity, etc. Reasonable rationality involves the evaluation and selection of criteria, their discussion and criticism, it is necessarily associated with intellectual intuition and creative imagination.

Other ways to define rationality - 1) presenting it as a special construct that does not have a universally objective referent, but plays an important methodological role ("partial" models of rationality by M. Weber, including: consistency, empirical adequacy, simplicity and other properties of conceptual systems), 2) consider rational theories or conceptual systems, as well as ways of behavior and activities that could provide productive intellectual and practical communication, rationality in such cases is provided by intersubjectivity, varieties of which were developed by K. Huebner, 3) the definition of rationality through its standard, which, since modern times, science, especially mathematical natural science, has been considered.

Rational and irrational. If rationality is determined by a set of criteria or a list of features, then the very choice of these criteria cannot be justified rationally and is made for some other reasons, for example, for value ones.

It is necessary to distinguish between **several meanings of the word "irrational"** ("irrational"), which are significant in the context of scientific rationality. **In the first sense, the irrational** is a self-sufficient and self-valuable non-rational form of human spiritual activity. Such an irrational has its own means of comprehending the world, for example, faith, mystical intuition, inner contemplation, and so on. This sometimes includes the sensual-emotional sphere of the spirit as opposed to the mind. Obviously, in such a context, scientific values and scientific faith can be found.

In the second meaning, the irrational, as an unknown sphere of the spirit, is not self-sufficient and valuable in itself, undergoes changes in accordance with changes in the mind, perhaps narrows down to its complete disappearance due to the expansion of the rational sphere. There is another hypothesis about the infinity of the irrational, which performs the function of eternal nourishment of the rational. In any case, here the irrational looks like as yet irrational, in this capacity it is a possible object of science.

The irrational is not a qualitatively lower or, on the contrary, higher (in relation to the rational) form of relation to the world. This is a different form in terms of the implementation mechanism. Irrational and rational are not always antipodes, they may well act as complementary aspects of the human spirit as a whole.

The ideal of humanitarian knowledge can be not only rational, but also irrational. One can observe in science and culture an alternation of periods in which the irrational organically interacts with the rational, and periods in which the irrational is opposed to the rational. Apparently, now we are going through a period of some rehabilitation of the irrational, with a general tendency to expand the rational.

Models of scientific rationality. One model differs from another by a certain set of features and rules, and the transition from one model to another looks irrational, since the transition rules are not formulated in advance. But this supposedly irrational transition is declared rational from the point of view of universal human rationality. This is a kind of paradox of rationality.

The idea of distinguishing models of rationality seems promising in the light of the complementarity of theories, paradigms, worldviews in the humanities. After all, moving from one method to another, from one theory or paradigm to another, moving from one picture of the world to another, the researcher actually changes the model of rationality at the same time. In any case, the basic classical standards of rationality remain inviolable: the laws of logic must not be violated, thinking must be clear and consistent, not confused, the organization of knowledge must be systematic, not a chaos of impressions.

Sometimes there are terms "soft", "non-rigid", "flexible" rationality. This refers to the departure from the so-called rigid rationality, i.e. from the standards of classical science as absolute criteria of rationality. In other words, this is not a rejection of the principles of rationality, but an account of the sociocultural and individual contexts of scientific research. Flexible criteria are associated with the choice of the research path, evaluation of the result, etc. They largely correspond to the real practice of scientific research.

12.3. Rationality and creativity.

Creativity and rationality are the two most important components of human spiritual and practical activity. Their connection was especially closely revealed at the beginning of the formation of modern scientific and technological civilization, which marked a special active-transformative, creative attitude of man to the world, the accompanying factor of which was scientific rationality.

Creativity involves the realization of artistic, scientific, inventive and other human potentialities. This entails the creation of new objects not given by nature. However, it is not an act of arbitrariness, although it includes impulsive, intuitive, unconscious and irrational moments that do not always coincide with the rational-rational sequence, logic and other requirements of the mind. Any creativity is carried out within the framework of a certain system of values that determines the model of behavior of the subject of creativity in a certain historical period. On the one hand, the value system includes implicit, unreflected and even irrational attitudes. On the other hand, this system of values includes clearly conscious ideals that have received rational expression.

At the same time, rationality appeared not only as a value of science, but also as a cultural value that determined many norms of human thinking and behavior. Rationality turned out to be one of the main value orientations of human creative activity, especially in science. However, the 20th century made people afraid and sometimes ashamed of a number of manifestations of creativity and rationalism, raising the question of the boundaries of creativity and rationality and exposing the problem of their relationship.

In a wide range of modern meanings of the concept of rationality, one can find an invariant, including: rules for understanding objects, principles for their explanation, interpretation, systematization, methods of provability, deducibility, organization of knowledge, principles and norms for constructing theories, etc. Even though it sounds paradoxical, typical examples of scientific creativity have developed, for example, methods for constructing theories, although the result of creativity must be unique. And attempts to build a theory of creativity, in particular, a theory of solving inventive problems, which is based on an algorithm for solving such problems, it would seem, not only deprive creativity of a halo of mystery, but also turn it into a rational-rational activity. The same can be heard about the procedure of modern technical creativity due to its high manufacturability.

In the history of philosophical thought, in addition to the epistemological study of the mind, there was also a socio-practical direction that considered the role of mind in human history. In this regard, rationality can also be understood as the principles of rational human activity, understanding of the world, attitudes towards nature, society and man himself. In the socio-practical functions of the mind, rationality and creativity are linked together. And in Marxism, this approach has received practical implementation in socialist revolutions and communist construction, which in practice turned out to be associated with huge sacrifices, violence, totalitarianism, violation of human rights and other manifestations of inhumanity. Therefore, awareness of the danger of unlimited social creativity raises the question of the limits of the socio-practical functions of the mind.

The boundary of scientific rationality in some cases was determined by the ability of the subject to apply some universal ideals and principles of reason, in particular, to find causes, laws, etc., and in others - by the object that determines the appropriate research methods. Thus, “rational fetters” were imposed on creativity, but its importance increased with the growth of the authority of science. In addition, the **historicity of rationality itself**, including scientific rationality, was realized. Modern hermeneutics, substantiating its own type of rationality, has done a lot to reveal the limitations of scientific rationality, and its penetration into the methodology of science both sharpened the problem of rationality and at the same time gave hope for its solution. The conceptual apparatus of hermeneutics makes it possible to enter a broad cultural and psychological context of scientific knowledge, shed additional light on scientific creativity, hope for the establishment of dialogue relations not only between cultures, but also with nature, which gives many authors grounds to almost crown hermeneutics as the modern queen of sciences.

The problem of the limits of creativity. Creativity as a value orientation presupposed the mastery of the object of creativity in at least three aspects: 1) natural objects and processes, 2) the social organism in order to reorganize it for the sake of justice, happiness, human development, 3) the person himself, primarily his thinking, in order to make him correct and organized. The subordination of thinking to the correct method did not contradict the idea of creativity and was regarded as a primary task. But one of the consequences turned out to be the “only correct” method of knowing and transforming the world, while other methods were rejected and persecuted as false or harmful. As a result, both creativity and rationalism were driven into such a narrow framework that they turned into their opposites.

Creativity and rationalism turned out to be inseparable from the idea of activity, progress, the fundamental significance of technology, and the priority of science. But activity, activity sometimes turned into violence. The cult of development and progress rejected completeness and stability. The idea of the fundamental importance of technology and production in general in relation to the sphere of the spirit gave rise to the phenomenon of lack of spirituality. The priority of science and scientific rationality rejects other forms of understanding the world as insufficient or incorrect. Therefore, the importance of humane initial values increases as an obstacle to the absolutization of rationalism and the prevention of the dangerous novelty of creativity.

Thus, the ideas of creativity and rationalism reveal not only positive, but also negative value coloring. It is wrong to write off violence, lack of spirituality, totalitarianism, technocracy only on random circumstances, socio-political conditions, incompetence and other manifestations of "unreason". They have a deeper basis, and most importantly, in modern conditions they require a new understanding.

13. Philosophical and methodological problems of historical models of science.

13.1.The concept of the growth of scientific knowledge of Karl Popper.

Karl Popper (1902 - 1994), an outstanding Austro-British philosopher, started a new tradition in the methodology of science: the analysis of the **development** of scientific knowledge.

Popper abandons the verification strategy and develops the opposite - **the strategy of falsification** (from English to falsify - to refute), the strategy of refutation.

Theories are tested and refuted in scientific discussions based on **criticism**. Criticism, refutation and deepening of theories and hypotheses ensures the growth of scientific knowledge.

Criticism, combined with the principle of fallibilism, Popper understands as a fundamental methodological component of science that ensures its development. The driving force of this development is the approximation to the truth by critically eliminating vicious versions and errors and by constituting more and more plausible theories. This circumstance not only brings scientific knowledge closer to the truth, but also brings together the varieties of scientific knowledge. The disciplinary convergence of sciences, according to K. Popper, occurs on the basis of their methodological unity. Such unity is stimulated by the implementation of the cross-cutting principles of critical rationalism.

Critical rationalism is not only a tool for scientific knowledge, but also a program for the activities of scientists, a requirement for them to develop the most unexpected and bold theoretical assumptions, open, however, to strict criticism.

Another main factor in Popper's concept is **the problem of demarcation** (from French demarcation - demarcation): delimitation of science and non-science, science and philosophy, science and ideology, empirical science and formalized science (mathematics, logic), heuristic methodology and dogmatic. Note that, unlike the neopositivists, who tried in every possible way to separate science from philosophy, K. Popper recognizes the necessity of philosophy for science (although he points out the differences between them).

The growth of knowledge is due to the progress of theories, which is associated with the process of "problem shift", which causes the need for new theories. The driving mechanism is the scientific method, which consists of trial and error: boldly putting forward theories, striving to do everything possible to show the fallacy of these theories, and temporarily accepting them if criticism fails. The method of trial and error is characteristic not only for scientific knowledge, but also for any knowledge in general, and in general is a method of any development. Nature, creating and improving biological species, operates by trial and error.

A rather convincing philosophical basis, the concept of three worlds, is brought into the already developed **concepts of falsification** and critical rationalism. According to Popper, our entire outer and inner reality is encompassed by three worlds:

- the first is the world of physical objects or physical states;

- the second represents the world of subjective (mental and psychic) states of consciousness;

- the third is the world of the objective content of thinking (confirmed and unconfirmed hypotheses, theoretical systems and problems, materialized and non-embodied projects, read and unread books, etc.).

The first and third worlds interact only through the second world. The third world is not localized anywhere and, however, is autonomous, since it exists regardless of whether people are aware of it or not. Therefore, Popper believes, we may not even understand, partially or completely, the objective content of certain theories and ideas of the third world. In turn, from theories and ideas, consequences unpredictable by their authors can unfold. Scientific thinking is an element of the third world. Although the third world is quite autonomous, we are constantly acting on it and being acted upon by it; thanks to this interaction, the growth of scientific knowledge occurs.

13.2. Scientific paradigm and scientific community. Scientific revolutions and normal science.

The model of normal and revolutionary science by T. Kuhn (1922-1996) was developed in the 60-70s. XX century as a sequence of evolutionary, "normal" periods, interrupted by jumps, revolutions. The bearer of scientific knowledge is **the scientific community** - scientists of a certain field of science who have received a similar education and work within the same paradigm.

A paradigm is a model, a set of fundamental ideas, values that determine a common understanding, principles of explanation and prediction, and, in general, the scientific activity of a given scientific community. An example of a paradigm: the Aristotelian picture of the world, which determined science in antiquity and the Middle Ages, or Newtonian mechanics, which determined the understanding and explanation of the world until the 20th century. The paradigm sets schemes for solving specific problems - puzzles. The paradigm defines research activity over a long period, while it works successfully. Kuhn called this period normal science.

Normal science is the activity of scientists in solving puzzles based on a paradigm within the scientific community.

In normal science, anomalies are gradually **accumulating** - facts that do not receive explanation, and problems that do not have a solution in this paradigm. So it was, for example, in the case of the discovery of oxygen or X-rays, which at first did not find an explanation. There comes a crisis of the paradigm, when it, previously unquestioned, begins to be criticized, alternative theories, concepts appear, and philosophical studies of the foundations of the paradigm are activated. As a result, **a scientific revolution occurs -** the complete or partial displacement of the old paradigm by the new one.

In the course of the scientific revolution, qualitative transformations take place in science, associated with a change in the scientific picture of the world, fundamental scientific theory, or the most characteristic ways of explaining and means of describing reality for a given era. Many consider the first scientific revolution to be the establishment of the heliocentric system of Copernicus and the formation of the first truly scientific theory - Galileo-Newton mechanics, which later acquired a paradigmatic character, becoming the core of the mechanistic picture of the world.

A classic example of a scientific revolution is the displacement of Newtonian mechanics by Einstein's theory and quantum mechanics, which led to the restructuring of all sections of natural science. After the scientific revolution, the period of normal science begins again, already on the basis of a new paradigm.

The significance of Kuhn's concept also lies in the fact that it overcomes naive cumulativeness and more or less adequately describes the course of development of science. However, the Kuhn model does not overcome all the difficulties of describing science, for example, how does continuity arise if the paradigms are incompatible, incommensurable?

13.3. Methodological evolutionism and anarchism. Cultural-historical models.

The evolutionary model of science was developed by the American philosopher of science Stephen Toulmin (1922-1997) shortly after Kuhn's concept. According to S.Tulmin, the scientific theory is based on the standard, the matrix of understanding adopted by the given scientific community. What does not fit into the matrix of understanding is considered an anomaly. The elimination of anomalies does not occur as a result of revolutions, as in Kuhn's concept, but in the course of the evolution of scientific theories, assimilating various innovations under the influence of not only scientific factors, but also economic, ideological, etc. This concept overcomes the principle of incommensurability, but does not explain where scientific revolution.

The concept of research programs - a special model of science - was proposed by the British philosopher, methodologist and historian of science Imre Lakatos (1922-1974). A research program is a chain of successive theories united by a core idea. The program consists of: 1. The hard core of the program - a set of scientific and philosophical assumptions that do not change and are not criticized as long as the program exists; 2.3 protective belt - auxiliary theories that protect the core from criticism, take a hit on themselves and change under the influence of new scientific data; 3. Methodological rules that contribute to the development of the program. For example, when perturbations in the motion of Uranus were discovered in the 19th century, scientists did not question Newtonian mechanics (the hard core of the research program), although the facts contradicted it. On the contrary, they proposed an auxiliary hypothesis about the existence of an unknown planet causing disturbances in the motion of Uranus. In this way, they modified the protective belt, preserving the rigid core - Newtonian theory - from criticism. The new planet was soon discovered and named Neptune. The concept of a research program corresponds to the common sense attitude: despite the mandatory criticality of scientific thinking, it is pointless to criticize everything at once. The Lakatos model is more adequate to the research reality in its dynamics, but it does not explain how it is possible to rationally describe the transition from one hard core to another. A rational description of the scientific revolution is the greatest difficulty of any models of science.

But the Lakatos model overcomes many difficulties in describing science. It gives a picture of developing theoretical structures. Lakatos specifically emphasizes the most important fact: for a program to progress, its theoretical growth must outpace its empirical growth.

The concept of methodological pluralism ("plural" - many) of the American philosopher of science Paul Feyerabend (1924-1995) argues that there are many equal types of knowledge, for example, theories, each of which gives its own vision of the world, and the task of science is to multiply the number of such alternative theories . P. Feyerabend calls such a task or requirement the principle of proliferation. Although this violates a number of scientific requirements: systematic, derivable, continuity, etc., Feyerabend's concept is quite popular, especially given the critique of rationality by modern postmodern philosophy. But Feyerabend also has opponents who believe that the principle of proliferation destroys science.

Historical models of science represent scientific knowledge in development and in rational models correctly capture many characteristics of science, however, none of them answers all the questions that arise.

An alternative to postpositivism as **a methodological concept is a cultural-historical approach.**

The general meaning of the cultural-historical approach in the study of science is as follows: science depends not only on the objects being studied and the means used, but also on the culture, of which this science is a part. For a generalized characterization of the role of social and cultural factors in the development of science, the concept of "sociocultural background of science" is sometimes used.

Such concepts are worthy of attention, but focusing on extra-scientific phenomena that determine science, they cannot describe in a general way the relationship between intra-scientific and extra-scientific factors in the development of science, and this is the main problem.

Another alternative to post-positivism version of the philosophy of science, which arose in the 60-70s of the twentieth century, was such a direction as **case-studies**. This direction of modern philosophy of science is a kind of synthesis of sociological, sociocultural and microhistorical research of science. We are talking about the study of the whole complex of conditions in which a fact, hypothesis, theory, research program or any other scientific knowledge arises. At the same time, in the context of the whole complex of conditions, individual motives are necessarily analyzed that lead specific scientists to accept or reject certain scientific concepts. Great importance is attached here to the study of the life path of individual scientists as a factor in their cognitive choice and behavior, which is associated with the biographical method in the history of science. Case studies are mainly carried out by representatives of the cognitive sociology of science, the culturology of science, and the anthropology of science (Michael Mulkay, Karin Knorr-Cetina, Steve Walgar, and others).

13.4. Paradigms in the humanities.

Humanitarian paradigms and paradigms of the humanities.

The term "paradigm" turned out to be so successful that it was widely used not only in scientific, but also in educational, journalistic and even fiction, especially since the mid-1970s.

Coexistence of paradigms. In culture, there are a large number of paradigms that differ both in level and sphere of functioning, which raises the question of their coexistence: commensurability, mutual influence, compatibility, predominance, struggle, displacement, fragmentation, unification, and determines their diverse influence that goes beyond that area. knowledge and activities where the paradigm was formed. The incompatibility of paradigms that displace each other is characteristic of classical natural science, based on rigid canons, and is not a general cultural norm. Paradigms generally have their own cultural and cognitive niches.

Different meanings of the concept of "humanitarian paradigms". Four main meanings can be found in the use of the term "humanitarian paradigms". First, the term is applied to paradigms of cultural activity. Man, not knowing how to live in a nature, remakes it, creating a cultural environment for his habitat. One of the mechanisms of cultural activity are paradigms as examples of cultural creativity. They are studied, say, by cultural studies as a humanitarian discipline, which is why they are considered humanitarian paradigms. Secondly, paradigms of high creativity in the field of art and literature are called humanitarian paradigms. The use of the term is fully justified, but with reservations, because research, knowledge, the acquisition of knowledge is not the main task of literature and art. Thirdly, in relation to technical practical and scientific activities, as well as to natural scientific research, the requirement of human dimension is put forward, and above all, taking into account possible risks and dangers for humanity. Such humanistic axiological imperatives are also called humanitarian paradigms, but they are not proper paradigms of the humanities or research activity in general. Fourthly, the paradigms of scientific research activity in the sphere of the spirit, in contrast to the studies of natural objects, to which man as a natural object also belongs, are paradigms of the humanities and, in this context, humanitarian paradigms. This also applies to the study of natural science texts and natural science thinking itself. Therefore, if a natural scientist reflects on his mental activity and his science, then he enters the sphere of humanitarian knowledge (“passes one floor up”) and must be included in existing humanitarian paradigms or create new ones. It is no coincidence that the methodology of science is ranked among the humanities, although it was created not only by the humanities. This applies to the history of science as well as to other disciplines that study science.

14. Functions of science and scientific research.

14.1. Scientific description and its philosophical and methodological significance.

Science performs various functions: systematization, classification, proof. Of particular importance are the description, explanation, prediction, understanding, which are actively discussed in the modern methodology of science.

A scientific description is a representation in the language of a given science of a certain subject area. Usually this is the fixation of empirical data with the help of symbols, graphs and other elements of the language, which constitutes empirical descriptions. Theoretical description means the use of idealizations, principles and other elements of the theoretical level of science.

In the humanities, a narrative description is studied, when a sequence of events is recorded in the form of a completed story, as if in the plot of a work of art, going to completion as to some goal, to the realization of meaning. This is characteristic of many historical studies, biographies and autobiographies, ecological and sociological texts. However, narrative descriptions are also common in natural science and in technical disciplines.

Descriptive procedures are also called descriptive. In modern descriptive procedures, standards for the accuracy and unambiguity of descriptions are of great importance.

Descriptivism is a methodological position popular at the turn of the 19th-20th centuries, represented by empirio-criticism and neopositivism (A. Mach, P. Duhem, L. Wittgenstein, W. Steiss). The essence of the concept is reduced to the idea that science cannot answer the question “why?”, but only the question “how?”, i.e. the function of science is not to explain, but to describe phenomena.

The concept of description is often used in a somewhat broad sense, when in the description of some objects not only empirical data is used, but also a wide range of theoretical concepts. An example is quantum mechanics, the meaning of which lies precisely in the description of certain objects of the microworld, but for such a description, almost all the functions of science are used.

14.2.Philosophical and methodological problems of scientific explanation and prediction.

Explanation is the function of science, which consists in establishing the essence of the object under study. The simplest **scheme of scientific explanation**: from statements expressing a certain law and the initial conditions in which an object is located, a statement describing this object is derived using the rules of deduction. In special terminology, it looks like this: the explanandum is derived from the explanans.

The explanation is fundamentally ambiguous, since the phenomenon being explained can be derived from various laws and theories. Therefore, there is no single correct theory. This poses important methodological problems: what theory to choose for explanation, what explanation can be considered reliable, correct.

Many types of explanation were developed by the famous German-American logician and science methodologist Karl Hempel (1905-1997) in the middle of the 20th century.

Types of explanation.

1. Nomological explanation. A nomological (from nomo - law) explanation is one when the explanance is a law or a law-like statement.

2. Causal explanation. In this case, the explanation is reduced to finding the cause or set of causes that caused the phenomenon. Such an explanation is also called causal (causa - cause).

3. Structural explanation. This explanation reveals the structure of the object, which determines the properties or behavior of the system being explained. For

example, certain chemical properties of a substance can be explained by the structure of its crystal lattice.

4. Functional explanation. It consists in revealing the functions performed by the given object. This type includes the explanation of the meaning of some social institution through its function within the framework of a general social system or, for example, in physiology, the explanation of the special biconcave shape of erythrocytes through their transport function and the associated need to maximize the surface of erythrocytes. Explanations of this kind are called teleonomic.

5. Genetic explanation. Here, the explanation is achieved by indicating the origin and features of the development of the object, when it is necessary to comprehend the history of the object, the stages of its development.

Specific kinds of explanation can be found in individual sciences. For example, in social disciplines, intentional explanations are used. This explanation is through an indication of the intentions, goals, intentions of people.

Prediction is a function of science, consisting in the derivation from some knowledge of information about the future state of an object or an as yet unknown phenomenon. Examples: prediction of solar and lunar eclipses, weather, results of political campaigns. A big problem is the accuracy of predictions, especially for multifactorial phenomena.

Scientific predictions, unlike extra-scientific (ordinary) or non-scientific (astrological, palmistry) predictions, are based on laws, theories and other components of science. Unscientific, extra-scientific, and anti-scientific explanations often rely on random regularities, concomitants, questionable analogies, and the like.

The prediction of unknown phenomena in the past or the reconstruction of a historical event is called **retrotelling**. The logical scheme of prediction is the same as that of explanations: the predicted phenomenon is derived from laws or theories. Therefore, one speaks of the symmetry of explanation and prediction.

14.3 Narrative and scientific explanation.

Modern problems of scientific explanation. The ideas about the structure of the explanatory procedure have significantly expanded, especially in connection with the success of the humanities. In addition to the traditional explanans and explanandum, they began to distinguish between the context and subtext of explanation, the ideals and norms of the explanatory procedure, the initial conditions of explanation, the semantic framework, preunderstanding and understanding, etc.

Subject of explanation. The subject of scientific explanation can be considered a scientist as a representative of the scientific community or a specific scientific school, using the scientific language, professing certain ideals of science. The subject of explanation accumulates in itself almost all channels of entry of personal, social, mental, linguistic, cultural factors into the explanatory procedure, being an indispensable element of the explanatory process. The concept of the subject of explanation allows one to go beyond narrow logicism or methodologism when studying the process of explanation.

Narrative and explanation. Of particular importance, in particular, for explanatory models in the humanities are specific narrative structures included in descriptive and explanatory procedures, for example, narratives. Among the distinguishing features of the narrative, they usually fix the presence of the ultimate goal of the narrative, from which all the events mentioned receive an explanation, the selection of the most important events that are directly related to the final goal and the ordering of events in a certain temporal sequence - plotting. In addition, the storyline determines the diverse forms of narrative, for example, progressive or regressive.

Narratives have a good explanatory power in areas that habitually use various narratives, for example, in the theory of literature and cinema, in historical disciplines, in philosophy, ethnography, theology, psychoanalysis. They connect the unknown with the known in various ways, including by indicating a certain rule, scheme, scenario, comparison, metaphor, allegory, etc.

In the natural sciences, it is also quite obvious that scientists use various rhetorical devices and narrative schemes to give their scientific results the appearance of objective, timeless and universal truths. So, Newton's "Optics" used the principles of construction and terminology of Euclid's works, borrowing their rhetorical power, although it contained only descriptions of experiments and their results.

14.4. Understanding as a function of science.

Understanding is the function of science, which consists in attributing meaning (or finding meaning, if, for example, a historical document is being studied) to what is understood. Meanings are given by the concepts of this theory. For example, in theoretical physics, meanings are given by constructs (ideal objects) of physical theories. To know these meanings is to understand the theory.

The problem of understanding in science is exacerbated when theories arise with their own semantic field, which does not coincide with the former. Then scientists often do not understand each other. For example, one of the founders of the electromagnetic theory, Hertz, did not understand Maxwell's electromagnetic explanations. Lorentz, who discovered the most important properties of the theory of relativity, did not understand Einstein and for more than twenty years tried to interpret them in the spirit of old ideas. Einstein did not understand Bohr and until the end of his days considered it possible to understand quantum phenomena within the framework of electromagnetic concepts. The general reason for this can be seen in the fact that the context for compiling the explanation and the context for reading it do not completely coincide, for example, due to different interpretations of the meaning of certain terms of the scientific language.

In understanding, there are irrational components in the form of insights, intuitive comprehension of meaning, imagination, empathy and other psychological factors. This is the first level of understanding. The second level of understanding requires the involvement of other means and methods of research: logical-methodological, axiological, cultural-logical. That is, in general, understanding is a rational procedure for identifying or attributing meaning.

An important methodological problem of science is that, proceeding from the understanding of the text as a materialized expression of spiritual culture, it is possible to de-objectify subjective meanings objectified in texts and, with their help, penetrate into the spiritual world of past eras, foreign cultures.

Understanding is subjective, because it involves meanings given by a person. Therefore, understanding was sometimes opposed to explanation as a formal conclusion. German philosopher Wilhelm Dilthey (1833-1911) even contrasted humanitarian knowledge as "understanding" natural science as "explaining". There are supporters of this approach even today.

In fact, explanation and understanding are intertwined. Any explanation is carried out in a certain semantic context that predetermines both the construction of the explanation and its understanding by those to whom it is addressed.

Types of understanding:

1) Understanding that arises in the process of linguistic communication taking place in a dialogue. The result of understanding or misunderstanding here depends on what meanings the interlocutors put into their words.

2) Understanding associated with translation from one language to another. Here they are dealing with the transmission and preservation of the meaning expressed in a foreign language, with the help of words and sentences of the native language.

3) Understanding associated with the interpretation of texts, works of fiction and art, as well as the actions and actions of people in various situations.

Scientific understanding may be present in any of these species.

Hermeneutic circle. The cornerstone of the problem of understanding is the principle of the hermeneutic circle, expressing the cyclic nature of understanding, which is expressed as a circle of the whole and the part: to understand the whole, it is necessary to understand its separate parts, and to understand the separate parts, it is already necessary to have an idea of the meaning of the whole. To understand the whole work, one must understand each chapter, but one can only understand each chapter by understanding the whole work.

The hermeneutic circle is partly broken by pre-understanding. The beginning of the process of understanding is pre-understanding, which is often associated with an intuitive understanding of the whole. Pre-understanding is usually given by tradition, the spiritual experience of the corresponding era, the personal characteristics of the individual and, in general, the level of his education and intelligence.

According to many authors, it is impossible and unnecessary to overcome the hermeneutic circle. Being in it, we pass from one interpretation to another, more acceptable or more adequate, or more interesting. Some researchers believe that the main problem is not how to get out of the hermeneutic circle, but how to enter it. Indeed, if there is no more or less acceptable pre-understanding, then it is impossible to enter the hermeneutical circle and there will be no understanding of the given text or the given problem at all.

Interpretation is a kind of understanding, consisting in the fact that the elements of a certain theory (symbols, formulas, constructs and generally sign systems) are given certain meanings (meanings) or the meanings are replaced. In the logico-mathematical and natural science disciplines, interpretation means the establishment of the subject area on which the corresponding elements, symbols, formulas are performed. In the humanities, interpretation means the interpretation of texts, for example, as a search for the author's intention or its socio-cultural conditioning, or as the discovery of special meanings seen by the reader, or as the study of special structures of the text, etc.

In the XVII-XIX centuries. theories and methods of interpretation were actively developed, as a result of which **hermeneutics** arose as a doctrine of understanding, especially thanks to F. Schleiermacher (1768-1834), W. Dilthey (1833-1911), M. Heidegger (1889-1976), H-G. Gadamer (1900-2001), Paul Ricoeur (1913-2005).

15. Philosophy of technology.

15.1. The concept of the philosophy of technology. The evolution of the concept of "technology".

The philosophy of technology is a philosophical discipline, the subject and task of which is the philosophical reflection on technology, the identification of its nature and patterns of development, as well as the assessment of technology in its relation to man. The term "philosophy of technology" was introduced by the German philosopher Ernst Kapp (1808 - 1896).

Technology as a field of human activity always attracts the attention of researchers. The thinkers of the era of antiquity, the Renaissance, the New Age, to one degree or another, turned to the consideration of the theoretical and philosophical problems of technology. In the XX century. The problems of philosophical analysis of technology were dealt with by researchers of various specialties: the German biophysicist, radiologist, neo-Thomist philosopher, one of the founders of quantum biology, Friedrich Dessauer, who became the founder of the religious trend in the philosophy of technology, existentialist philosophers, but as different in their views as Martin Heidegger, Karl Jaspers, Xans Jonas, American historian and sociologist Lewis Mumford, French philosopher, sociologist and lawyer Jacques Ellul, famous Russian religious philosopher Nikolai Berdyaev, famous Spanish philosopher, critic of mass society, Jose Ortega y Gasset and others. But only since the 1960s did philosophical studies of technology acquire the status of an independent philosophical discipline.

The problematic field of the philosophy of technology: from a brief definition of the very concept of technology to the study of its historical development, from consideration of the specifics of technical knowledge to its relationship with fundamental sciences, art, politics, economics, from the search for a new concept of interaction between man and nature to a new behavior in the modern technosphere, from questions of ethics to problems of logic, from rationalism and orderliness to irrationalism and chaos in the complex industrial-information world.

The concept of technology. In a broad sense, technology usually means the world of artifacts, that is, the world of the artificial, the second nature created by man, in contrast to the first, to human. The concept of "technology" is also associated with the corresponding activity, which refers not only to the production of artifacts, but also forms specific technical and technological knowledge about them. The famous German philosopher Martin Heidegger (1889 - 1976) gave technology another meaning: a special attitude to the world as a material, a source of matter and energy. This meaning was largely laid down in modern times by becoming a science, but it was really embodied in technology.

In a narrow sense, technology is called the world of means-artifacts, primarily machines and mechanisms that facilitate and improve the life of a person and society. True, technology factors have recently been discovered that complicate and complicate the life of man and mankind. The philosophy of science is precisely called upon to deal with this contradictory situation. The activity corresponding to the world of artifacts is called engineering, design, construction and is associated with the technical sciences.

The evolution of the concept of technology. The concept of "technique" goes back to the ancient Greek word "techne", associated with some orderliness of rules, actions, results. "Techne" gave rise to a whole group of terms: "technique", "technique", etc., as well as a huge semantic block, where almost all manifestations of technogenic civilization are connected in one knot: from modest craftsmanship to the transformative role of science and technology.

Techne is understood by the ancient Greeks quite broadly: handicraft skills and high art were considered mastery and differed from inspiration and obsession, which were out of order.

Craftsmanship, especially as reproduction, continues to be valued in the Middle Ages, with Leonardo da Vinci painting and technical invention were of the same order of things as techne in antiquity. Only beginning with Galileo is the universalism of the Renaissance gradually overcome. In modern times, techne as an activity is divided into engineering and art, and is associated mainly with the former. Here the method begins to prevail as a rational sequence of actions, and a close connection is established with the methods of scientific research.

With the development of technology, the very content of this concept also changes significantly. At the end of the XVIII century. there was a leap that covered the entire technical side of human life as a whole, which is now called the industrial revolution. The turning point was the discovery of the steam engine (1776), followed by a universal engine - an electric motor (dynamo in 1867). The energy derived from coal and the power of water was sent wherever it was needed. The old mechanics had only a limited power in the form of the muscular power of man or animal, the power of wind or water, setting the mills in motion. What was new now was that a thousand times greater power was at the disposal of man, which, as at first it seemed, could be increased to infinity.

The modern perception of the term "technology" is largely related to its classical understanding, however, scientific and technological progress has made serious changes and expanded the subject field of this concept. Today, the influence of technology extends to organic and inorganic nature. In the field of organic nature, this is agricultural technology, as well as biotechnology, which makes it possible to include all biology in the subject field of technology. In the field of inorganic matter, these are construction equipment, electrical engineering, heat engineering, physical and chemical engineering, energy technology, etc. At the same time, there is a “technique” of thinking, discussing, studying, memory (mnemonics), painting, drawing, playing on musical instruments, as well as the technique of managing people, production, the state, etc.

Therefore, the modern understanding of technology in the broad sense of the word is, in addition to artifacts and related activities, also a set of skills that make up the professional characteristics of a particular type of human activity.

15.2. Science, technique, technology. Nanoscience and nanotechnology.

Stages of the relationship between science and technology. The evolution of the relationship between technology and science, starting from the era of modern times, allows us to distinguish three stages.

1) The leading role of technology. The first stage (about 1660-1750) begins mainly in England. The technical principle of cognition in the form of a mechanical picture of the world acts as a universal model and model of scientific explanation. There was an image of the world as a mechanical clock. The orientation of science, which is empirical in its essence, towards technology is manifested not only in the application of scientific knowledge through technology in production and the answers of science to the demands of production, but also in the significant development of the technology of scientific tools.

2) Separation of science and technology. The next stage, from the middle of the XVIII century. to the beginning of the 20th century, is the period of institutional differentiation of science and technology, their relatively independent, independent development as social institutions. Within the framework of science, the importance of theoretical consideration and substantiation of scientific propositions is growing. Science turns from empirical into theoretical, although the importance of empirical knowledge does not decrease, but the share of theoretical knowledge increases many times over. The technical field is dominated by the work of brilliant self-taught inventors: from James Watt, a Scottish engineer, mechanical inventor, to Thomas Edison, an American inventor who received more than four thousand patents. True, it should be noted that invention is often much closer to science than it seems. So, James Watt was considered and is now considered a mechanic, that is, not a scientist. The mechanic at that time was much lower in social status than the scientist. But Watt, in terms of his level of knowledge, corresponded to the professors-scientists with whom he collaborated, and who noted this. It was just that at that time technology and science were institutionally separated, which did not allow for a proper assessment of Watt's achievements.

3) The leading role of science. Unfolding industrialization has turned technical innovation into a defining element of production. Technical knowledge could no longer be limited to generalization and improvement. The information revolution and the information society have significantly increased the demand for science, giving rise to the process of the so-called scientification of technology. In the XX century. science is reaching a stage where it can be oriented towards practical ends, creating new technologies that individual inventors are unable to develop. This was especially evident at the beginning of the second half of the 20th century, when scientific discoveries quickly become branches of production, as happened, for example, with chemical synthesis. With the development of digital technologies at the turn of the XX-XXI centuries. this process has been multiplied.

The relationship of science and technology in modern conditions. The differences between science and technology are not absolute. The processes of scientification of technology and the technization of science determine each other, erasing the boundaries separating science and technology, which is especially noticeable at the turn of the 20th-21st centuries. The influence of modern technology on society is manifested not only in the sphere of material production and science. The development of military equipment, and especially of strategic means, determines important aspects of international politics, relations between countries, and is reflected in the state of their economies. The education system, art, everyday life and culture in general are being significantly transformed under the influence of modern high-tech technical means. Cinema, radio, television, the Internet and their technical and technological capabilities have brought to life new types of art and literature, produced new activities. The emergence and distribution of technical teaching aids, especially controlling and teaching machines and devices, simulators, etc., made it possible to increase the efficiency of the educational process in secondary and higher schools, to implement the principles of programmed learning. More and more household appliances are being developed, used to facilitate many household chores, to create comfort in everyday life. Vending and household machines have become widespread. In many countries, special household services have been formed that deal with the introduction of household machines, their maintenance and repair. Modern technology, due to its scientific content, stimulates the development of physical culture, sports, and medicine. For example, the use of a laser as a surgical instrument during operations determined the development of several branches of medicine. Technology also affects the psychology and worldview of a person.

The development of many types of modern technology, due to their complex science intensity, turns into a high cost, which is often beyond the power of individual corporations and countries. There is a need to combine the efforts of scientific institutions in many countries to obtain new scientific and technical results, which leads to international scientific and technical cooperation. Thus, cooperation in the field of television made it possible to create the Intervision and Eurovision systems, scientific and technical cooperation in the nuclear industry is coordinated by the International Atomic Energy Agency. Many countries carry out technical cooperation in space exploration. International cooperation in the field of science and technology is an effective means of implementing major targeted programs aimed at solving the most important problems of scientific and technological progress.

Technique and technology. Technology is usually understood as a set of actions for the production of an artifact. In this regard, technique is sometimes defined in terms of technology. As an independent, specific concept of "technology" was formed much later than the concept of "technology" and "mechanics". In the transition from technology to technology, there is some narrowing of the Greek concept of "techne": for example, from technology as a skill, skill in creating some unique product to its serial production, moreover, production according to stable standard rules that can be correlated with the concept of "algorithm" . In this regard, we can say that real art and technology standards are incompatible.

The phenomenon of technoscience. Nanoscience and nanotechnology. Assessing the level of modern technology, the word "high" or "high-tech" is usually used. Technological "height" is associated with a high degree of knowledge intensity of such technologies, and among them, nanotechnologies are most often spoken of. In addition to the scientification of modern technologies, there is a process of technologization and technologization of science. In particular, the phenomenon of technoscience is being formed. The term "technoscience" was coined by the French philosopher Gaston Bachelard in 1953, and it entered into wide use in the 21st century. Technoscience means the social, in particular, technological context of science, which must be taken into account in science research.

Nanotechnology is an interdisciplinary field of fundamental and applied science and technology that deals with a combination of theoretical justification, theoretical and practical research methods, in particular, analysis and synthesis, as well as methods for the production and use of products with a given atomic structure by controlled manipulation of individual atoms and molecules . The term "nanotechnology" is associated with the name of the famous American engineer Eric Drexler (b. 1955) and with the corresponding unit of measurement: a nanometer is one billionth of a meter or one hundred thousandth of the thickness of a human hair.

Nanotechnology is a product of interaction, synthesis of such scientific disciplines as physics, biology, informatics, cognitive sciences (psychology, epistemology, etc.). Nanoscience is also associated with **nanotechnology**. However, there is a difference between them. Nanoscience is the basis for nanotechnological research.

The peculiarity of nanoscience lies in the fact that ultra-small particles obey different laws than ordinary macro-objects. First, the motion of these particles is carried out according to the laws of quantum mechanics. Secondly, on the scale of nanoparticles, almost all atoms and molecules of a substance are not in a “free floating” or “herd state”, but near the surface, which makes them relatively easy to use. For example, nanoscale particles are able to absorb certain colors, turning, say, white into red. Biologists are well aware of the blue butterfly, so bright that the color of the wings is visible at a distance of hundreds of meters. However, the blue pigment is not found in butterfly wings. Butterfly wings are covered in tight rows of transparent scales that form layers that reflect blue light, micro-level studies have shown. The thickness of each layer is 62 nanometers, and the distance between the layers is 207 nanometers. These spatial relationships make it possible to reflect flickering blue light, while other relationships would generate reflections of other colors. This effect is used by scientists working on the creation of cosmetic products that can generate various bright colors in the same way as butterfly wings.

Unlike microtechnology, in which billions of atoms are an "unmanaged herd", molecular nanotechnology is high-precision molecular engineering, where each atom or molecule has a specific place. Thanks to this precision, nanomaterials combine qualities such as strength and lightness. For example, unlike a simple steel bar that underlies a building structure, a stronger and lighter nanobeam can also be equipped with special sensors that signal the degree of stability of this structure.

Molecular nanotechnology **is associated with the threat of the so-called** "sticky gray mass", which self-forming "nanomachines" can fill the Earth and absorb all life on it. Such a scenario caused a certain distrust of the scientific community in the development of molecular nanotechnology. However, supporters of the development of molecular nanotechnology point to the fact that the processes of molecular assembly in nature occur continuously: cheap resources (water and soil) and cheap energy (sunlight) are converted into useful building materials (forest).

MIT scientist Neil Gershenfeld, who was named one of Scientific American's 50 leaders in science and technology, is developing the idea of "custom manufacturing." We are talking about creating machines that would make it possible to implement any project created on a computer with a simple keystroke. With the help of computers, the employees of his laboratory not only design, but also create objects of their choice: motherboards, diesel engine sensors, and even works of art. The creation of individual production based on molecular nanotechnology will merge the industrial and information technology revolution, which will result in the ability to instantly and inexpensively move data anywhere in the world and turn virtual projects into real objects in the right place. Moreover, the cost of these facilities would consist only of the sum of the cost of raw materials and energy costs.

15. 3. Technique in the scientific and philosophical-anthropological context.

Researchers in the field of philosophy of technology are seriously interested in such problems as the features and social consequences of modern scientific and technological development, the ethical problems of modern engineering and technology, the formation of a value system in an industrial and post-industrial society, technical education, upbringing, etc. These problems affect the interests of all mankind . Moreover, the danger lies not only in irreversible changes in the natural environment. The direct consequence of these processes is to change the person himself, his consciousness, perception of the world, his value orientations. Sometimes discussions on this score take on the character of a dilemma: technicism or humanism. Naturally, recently the scales have been leaning towards humanism, the humanization of technical activity, technical education, the subordination of technical values to humanitarian values.

It is obvious that without the philosophical study of technology, that information, value, problematic, conceptual space would not have arisen in which detailed scientific research began using scientific means of mathematical modeling, accurate calculations and forecasts of the economic, energy, raw material state of the planet.

Scientific research of technology in the context of global problems.

At the beginning of the XXI century. humanity is faced with the need to solve problems of a planetary order: pollution of the environment with industrial waste, depletion of irreplaceable natural resources, imbalance in demographic processes, the danger of a radioactive catastrophe, etc. All this makes us think about the goals and prospects of technical development, about measures for its possible limitation.

In 1972, the publication of The Limits to Growth, the first report of the Club of Rome, now a world-famous international public organization, became sensational. This report was prepared based on the results of a study conducted by a group of scientists at the Massachusetts Institute of Technology, led by Dennis Meadows, as part of the Global Threats to Humanity Project. The conclusions reached by scientists turned over all the usual ideas about the goals and prospects of human existence. According to the forecast of Meadows and his colleagues, humanity is confidently moving towards a global catastrophe, which can only be avoided by taking appropriate measures aimed primarily at limiting and regulating the growth of production and the extraction of natural resources. For almost half a century, scientists from different countries, at the initiative of the Club of Rome, have prepared 50 reports. They are based on large-scale studies of global problems of our time.

Only by uniting in the face of imminent and universal danger, humanity is able to show the political will to carry out joint actions aimed at ensuring its survival. The Club of Rome in its anniversary report “Come on!” (2017) called for a new Enlightenment, a holistic worldview, a planetary civilization, an alternative economy as steps to be taken immediately.

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