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SCIENCE IS THE MAIN COMPONENT AND DRIVING FORCE OF SOCIETY

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INTRODUCTION

Modern science has a significant impact on all aspects of human practical activity. With its help, dozens of expensive biologically active substances are obtained today, including hormones, enzymes, vitamins, antibiotics, and drugs. It plays a significant role in medicine, since thanks to the use of genetic engineering, it is possible to produce such valuable drugs as human insulin, interferons, and monoclonal antibodies in unlimited quantities. Biotechnology plays an extremely important role in the ecologization of industrial production based on the creation of waste-free processes: the use of biotechnological processes for water purification, biological methods for destroying pests of agricultural crops are confidently displacing seemingly competitive chemical insecticides, energy- and resource-saving production has been developed and implemented, and renewable energy sources are obtained.

The solution to such problems as food shortages and protein deficiency will probably be found with the help of biotechnology by reducing the cost of producing amino acids − a necessary component of pet food, by developing methods for obtaining single-cell protein (feed) by processing paraffins or other available raw materials: cellulose, agro-industrial or agricultural waste, wastewater, as well as by cloning plants and selecting highly efficient varieties. Scientists have calculated that every day 2-3 billion dollars are thrown away all over the planet as garbage, junk, waste, and money goes to the "other world" at a speed of 70 km / h. In 1960, the German brewer Frei Heineken traveled to the island of Curacao, near Venezuela in the Caribbean Sea, and on the beach he saw millions of bottles from under his beer and he was struck by the idea of building a house out of them, 15 million are thrown away in the world every day. bottles, 100,000 bottles are needed to build a house, such housing is quite warm, bright and does not require a significant amount of building materials. Calculate how much it would be possible to reduce the amount of household waste of this type on the one hand and improve the ecological situation on the planet as a whole. Here are the biggest disasters that have affected humanity during the 20th − 21st centuries and the most dangerous for city life[1 2 3]:

The biggest disasters of the 20th century:

1. Ukraine, 1986 − the accident at the Chernobyl nuclear power plant is called the biggest disaster caused by human activity. Given its psychological consequences and the general fear that it caused throughout the world, this may be true. In Ukraine alone, 3,278,521 people, including 1,264,329 children, were affected by the accident at the Chernobyl nuclear power plant. The number of liquidators includes 340,654 people, of whom 86,775 were directly involved in the liquidation of the accident. The number of disabled people reached 91,200 people. 90,784 people were evacuated from contaminated areas to Ukraine in the period from 1986 to 1990.

2. Armenia, 1988 − a needle in a haystack, the rescue service was sorting out collapsed buildings in the hope of finding "life" in the ruins. The most terrible earthquake of the 20th century. buried 25,000 people and caused material damage of 2.5 billion euros.

3. California, 1994 − an earthquake "swallowed" a house as a result of the Taliban, 50,000 people died, more than 3,000 were injured, the damage is estimated at 30 billion dollars.

4. New Orleans, 2005 – Hurricane Katrina broke the dam, the entire lake “burst”, more than 1,000 residents died, flood damage is estimated at 129 billion dollars.

5. Florida, 1992 – Hurricane Andrew, which swept along the coasts of Florida and Louisiana, swept away everything in its path, its victims were 60 people, damage was caused to the tune of 38 billion dollars.

6. Asia, 2004 – oceanic requiem: as a result of the last devastating tsunami, Indonesia, India, Sri Lanka, Malaysia, Thailand, Bangladesh, Somalia were affected. The number of victims in Southeast Asia is from 150 to 170 thousand people, the number of victims is 5 million. According to UN estimates, 14 billion dollars are needed to eliminate the consequences of the natural disaster and rebuild the coastal infrastructure.

7. China, 1998 − Chinese soldiers tried to seal a broken dam with their bodies. After prolonged rains, the dam’s waters burst, according to official data, 300 people died during the worst flood in the last 40 years, and damage amounted to 37 billion euros.

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[1] Зербіно Д., Гжегоцький М. Екологічні катастрофи у світі та Україні. Львів: БАК. 2005. 280 с.

[2] Річард Доккінз Наука для душі нотатки раціоналіста / пер. з англ. Д. Прокопик. Київ: Наш формат. 2019. 384 с.

[3] Кейті Мак Повний кінець на думку астрофізиків/ пер. з англ. А. Дудченко.Київ: Лабораторія. 2021. 192 с.

8. India, 1984 − poisonous gas leak in Bhopal, the death toll according to some data reached 6,000 people, about a third of this number were children. 20,000 people went blind, 200,000 people were found to have serious brain damage and paralysis. Children who were born soon after had physical and mental disabilities. The contaminated area was 5 km long and 2 km wide. The toxic gas completely destroyed the crops within a radius of 167 km.,, the land remained barren for a long time

9. Japan, 1995 – an earthquake measuring 7.2 on the Richter scale, which occurred on January 17, 1995, demolished part of a highway near the Japanese port city of Kobe. 4,499 people died, the damage amounted to 132 billion dollars.

10. Italy, 1963 – the breach of the Vaion dam took 2,600 people with it, the damage from this disaster was estimated at 900 million dollars.

city a:

1. Chernobyl (Ukraine) − a tragedy that has been said very little. Today, the number of people affected by radiation in this area is 5.5 million. The nuclear disaster that occurred on April 26, 1986, when during tests at the Chernobyl nuclear power plant an explosion melted the reactor core, brought a hundred times more radiation than the atomic bombs dropped on Hiroshima and Nagasaki.

2. Sumgait (Azerbaijan) is another center of the chemical industry of the post-Soviet space. Today, more than 275 thousand people live there, contaminated with heavy metals, oil waste and other chemicals. Children in this area are born with such genetic abnormalities as mental retardation and bone disease.

3. Vapi (India) − a city located at the end of a 400 km long belt of industrial complexes. It is home to over 1,000 industrial enterprises. The mercury level in Vapi's groundwater is almost 100 times higher than normal, and the air is full of heavy metals. The number of infected residents suffering from various chronic diseases has exceeded 70,000 this year.

4. Tianjin (China) is an industrial center for lead production, one of the most polluted places in China. The concentration of lead in the air and soil is almost 10 times higher than the permissible norm. The lead content in grain crops growing in this area is 24 times higher than the norm.

5. Sukinda (India) is home to the world's largest chromium mines. Most of the company's waste is discharged into rivers and lakes, as a result of which carcinogenic substances are present in almost all water supplies of the city. The city is home to over 2.5 million people, almost 90% of the population suffers from cancer.

6. Norilsk (Russia) – considered one of the most polluted cities in Russia, it often snows black, and the air smells of sulfur. Norilsk is home to the

world's largest heavy metal processing plants – copper, lead, nickel, selenium and zinc. Today, the city is home to about 134,000 infected people suffering from respiratory diseases. Since 2001, foreigners have been banned from entering the city.

7. Linfin (China) – the heart of China's coal industry in Shanxi Province. The level of sulfur dioxide and other harmful particles in the air significantly exceeds the norm, so much so that the air becomes gray and visibility deteriorates. The city has more than 200,000 infected people suffering from pneumonia, lung cancer and bronchitis.

8. La Oroya (Peru) – compared to other cities, this settlement is relatively small, with only 35,000 people living in it. However, more than 95% of residents are infected with serious diseases associated with high levels of lead in the blood. American factories for the extraction of minerals such as lead, copper and zinc are located on the territory of this fortification. A huge amount of sulfur dioxide is emitted into the atmosphere, which often causes acid rain.

9. Kabwe (Zambia) − at the beginning of the last century, large reserves of lead and cadmium were discovered here. Later, large enterprises for the processing of these metals were built there, as a result, today the level of air pollution with heavy metals is 4 times higher than the permissible norm. The number of infected people in the city exceeds 250 thousand people, they suffer from acute blood poisoning, which leads to frequent vomiting, diarrhea, lung disease and muscle atrophy.

10. Dzerzhinsk (Russia) − according to reports from ecologists, in 1930 − 1998 More than 200,000 tons of chemical waste, including the most dangerous known neurotoxins, were buried here. The city's water is partially contaminated with dioxanes and phenols, and the level of pollution is reportedly 17 million times higher than safe levels, with an average life expectancy of 45 years.

Despite significant progress and the approach of the 21st century, the problems on the planet are not getting any less. It's just that in some regions, they have been almost completely solved − Western Europe, the EU, while others have become waste dumps − most African countries, some South American countries, and here science, no matter how progressive it is, cannot solve this issue.

1. The emergence and evolution of science. Scientific activity and its types.

The National Doctrine of the Development of Education in Ukraine in the 21st Century defines that the main factors of the further development of education are: the unity of education and science as a condition for the modernization of the education system; sufficient funding for science and support for domestic scientific schools; fundamental nature of education, intensification of scientific research in higher educational institutions; formation of the content of education based on the latest scientific and technological achievements; innovative educational activities in educational institutions of all types, levels of accreditation and forms of ownership; legal protection of educational innovations and results of scientific and pedagogical activity as intellectual property; involvement in scientific activities of gifted students and students, pedagogical workers; deepening of cooperation and collaboration between educational institutions and scientific institutions, wide involvement of scientists of the National Academy of Sciences of Ukraine and academies in the educational process and research work in educational institutions; creation of a scientific and information space for children, youth and the entire active population, using the possibilities of new communication and information means for this; implementation of targeted programs that contribute to the integration of education and science; intensive development of pedagogy and psychology, including them in the list of priority areas of development of science in Ukraine. The emergence of science as a sphere of human activity is closely related to the growth of people's intelligence. Work as an activity is caused first by the struggle for survival, and then by the desire for comfort − this is only one of the driving forces of progress. On the other hand, when the first human needs are satisfied, the second driving force awakens − interest in oneself, colleagues, and the environment. Thus, two spheres of human interest are distinguished − material (the desire for comfort) and spiritual (the desire to satisfy curiosity). Labor activity includes the production activity of a person, which is aimed at obtaining a material product, and the spiritual sphere of activity includes art, the service sector, and science, which provide the intellectual (spiritual) wealth of society. The concept of science is based on its content and functions in society. Modern scientists define science as a socially significant sphere of human activity, the function of which is to develop and use theoretically systematized knowledge about reality, it is an integral part of the spiritual culture of mankind. As a system of knowledge, it encompasses not only factual data about objects of the environment, human thought and action, but also certain forms and methods of their awareness. Science acts as: a specific form of social consciousness, the basis of which is a system of knowledge; the process of knowing the laws of the objective world; a certain type of social division of labor; the process of producing knowledge and its use. Thus, science has historically developed into a clear system of concepts and categories, interconnected by reasoning, judgments and conclusions. Of course, not all knowledge can be considered scientific. Thus, the knowledge that a person receives only on the basis of simple observation is not scientific, they are important in human life, but do not reveal the essence of phenomena, the relationship between them, which would allow explaining the principles of the emergence of the process, phenomena and their further development. The goal of science is to learn the laws of nature and society, the corresponding influence on nature and obtaining results useful to society. The subject of science is the interconnected forms of the movement of matter or the features of their reflection in the minds of people. It is the material objects of nature that determine the existence of many branches of knowledge. The reliability of scientific knowledge is determined not only by logic, but first of all by its mandatory verification in practice, because it is science that is the main form of cognition and the consolidation of knowledge about the surrounding world into a certain system and its use in the practical activities of people. Scientific activity is intellectual and creative aimed at obtaining and using new knowledge and has varieties: scientific research; scientific and organizational; scientific and informational; scientific and pedagogical activity, etc.

The main periods of the development of science. Historically, science has gone through a long and complex path of development from primary, elementary knowledge about nature to the knowledge of complex laws of nature, social development and human thinking. The first elements of science appeared in the ancient world in connection with the needs of social practice and were of a purely practical nature. Even at the dawn of its development, humanity improved living conditions by learning and transforming the world around it. Over centuries and millennia, experience was accumulated, generalized in a certain way and passed on to subsequent generations. The mechanism for imitating acquired knowledge was gradually improved by establishing certain rituals, traditions, and then writing. Thus arose the historically first form of science (the science of the ancient world), the subject of study of which was all of nature as a whole. The initially created (ancient) science was not yet divided into separate isolated branches and had features of natural philosophy. Natural philosophy corresponded to the method of naive dialectics and elemental materialism, when ingenious guesses were intertwined with fantastic fictions about the surrounding world. In the 5th century BC, mathematics began to stand out from the natural philosophical system of ancient science as an independent branch of knowledge, which was divided into arithmetic and geometry. In the middle of the 4th century BC, astronomy became isolated. In the scientific and philosophical system of Aristotle, the division of science into physics and metaphysics (philosophical ontology) was outlined. Further, within this system, logic and psychology, zoology and botany, mineralogy and geography, aesthetics, ethics and politics began to stand out as independent scientific disciplines. Thus, the process of differentiation of science and the allocation of separate branches of knowledge independent in their subject and methods began. From the second half of the 15th century, during the Renaissance, a period of significant development of natural science as a science begins, the beginning of which (mid-15th century − mid-16th century) is characterized by the accumulation of a large amount of factual material about nature obtained by experimental methods. At this time, further differentiation of science occurs; universities begin teaching the basics of fundamental scientific disciplines − mathematics, physics, chemistry. The second period in the development of natural science, which can be characterized as revolutionary in science, occupies the time from the middle of the 16th century to the end of the 19th century, it was during this period that outstanding discoveries were made in physics, chemistry, mechanics, mathematics, biology, astronomy, geology. The geocentric system of constructing the world, which was created by Ptolemy in the Pst., is replaced by a heliocentric one (M. Copernicus, G. Galileo − 16-17th centuries); the laws of universal gravitation were discovered (I. Newton − the end of the 17th century), the conservation of mass in its chemical transformations (M. Lomonosov, A. Lavoisier − the second half of the 18th century), the basic laws of heredity were discovered (G. Mendel − the end of the 18th century). In the second half of the 19th century, D. Mendeleev discovered the periodic law in chemistry. A real revolution in natural science occurred as a result of such great discoveries: the creation of the evolutionary theory of Charles Darwin and the law of conservation and transformation of energy. The revolutionary processes that took place in science in the 16-19th centuries led to a fundamental change in views on the surrounding reality. The first stage of the revolution (mid−16th century − end of the 18th century) allowed us to conclude that behind the appearance of phenomena there is a reality that science is called upon to illuminate. The second stage of the revolution (the end of the 19th century) led to the collapse of the views according to which nature with its objects and connections was considered unchanging and moving forever in the same circle. The decisive role in general was played by I. Kant and P. Laplace, who created the cosmogonic theory. At the end of the 19th − beginning of the 20th century. the revolution in natural science entered a new, specific stage. Physics crossed the threshold of the microcosm, the electron was discovered (J. J. Thomson, 1897), the foundations of quantum mechanics were laid (M. Planck, 1900 p.), the discrete nature of radioactive radiation was discovered. In the 20th century. the development of science throughout the world is characterized by exceptionally high rates. On the basis of the achievements of mathematics, physics, chemistry, biology and other sciences, molecular biology, genetics, chemical physics, physical chemistry, cybernetics, biocybernetics, etc. were developed[4].

2. Features of science in the era of globalization

In modern conditions, the nature of scientific research and the approach to the study of natural phenomena have changed dramatically. The previous isolation of individual disciplines has been replaced by their interaction and penetration into each other. Now any object of nature or phenomenon is studied in a complex of interconnected sciences. The rapid pace of development of science in the 20th century. stimulated the creation of scientific knowledge, which studies the laws of the functioning and development of science, the structure and dynamics of scientific activity, the economy and organization of scientific research, and the forms of its interaction with other spheres of the material and spiritual life of our society. Science arose as a result of the needs of production in the 18th century, when numerous chaotic data of cognition were ordered, isolated and brought into a causal relationship and knowledge became science, and science approached its completion, that is, it was connected: on the one hand, with philosophy, on the other − with practice. Mass production, cooperation in large enterprises with the use of machines, for the first time on a large scale subjugate the forces of nature (wind, water) and the production process itself. The use of the forces of nature in production on a large scale, their inclusion in capital, coincide with the development of science as an independent factor of the production process. If the production process becomes a factor, a field of application of science, then science, on the contrary, becomes a factor, a function of the production process. The accumulation of empirical knowledge over millennia has allowed the development of tools of labor, albeit very slowly, but in the direction of increasingly complex devices. The empirical era in production lasted almost until the 20th century. Having reached a certain limit of complexity, empirical technology exhausted its capabilities. The practical needs of society determined the development of technical sciences, which caused progress in technology. Through technology, science began to increasingly influence production. Science began to turn into a branch of social production, which produces new information necessary for society. The process of producing new information took on the character of accelerated reproduction, and science began to develop rapidly, which meant the beginning of the era of the scientific and technological revolution. In the scientific community, three scientific directions are distinguished: classical,

[4] Ювал Ной Харарі 21 урок для 21 століття / пер. з англ. О. Дем'янчук. Київ: Book Chef. 2022. 416 с.

non-classical (industrial society) and post-non-classical (post-industrial society), which arose respectively in the 16-17, 19 and the second half of the 20 centuries. Due to the specific conditions of development, classical science arose in the struggle against scholasticism and authoritarianism of medieval thinking, which was based on methods of measuring the object of knowledge, regardless of the subject. The past XX century went down in history as the century of rationalism and reason. About 500 natural sciences and 300 humanities and the techniques and technologies generated by them declared their focus on protecting human interests in nature and society. In industrial society, there is a concentration of production and population, urbanization, the formation of a system of values oriented towards efficiency, rationality to the capabilities of the natural environment, that is, at any price. Society, having reached an extremely high level of knowledge and development, has created a real threat to its existence. In fact, for the first time in history, in the first half of the 20th century, humanity reached a critical point and in the second half of this century, having crossed the threshold, it really entered the period of the "Great Crisis". Two world wars, atomic bombings, genocide have been experienced, new diseases have appeared, the environmental problem has become more acute, and this raises doubts about the absolute progress of the scientific and technological path of development. After all, the powerful development of the economy based on the achievements of scientific and technological progress has turned out to be destructive for the biosphere, the state of the environment has deteriorated, natural resources are being depleted, as a result of which poverty is growing, all spheres of social life are degrading, and spiritual values are being lost. Based on the analysis of the past, modern post-non-classical science chooses the path of anthropospheric, biospheric or noospheric development. At the same time, economic growth here is achieved on the basis of new technologies, there is a transition from a commodity-producing to a service economy, the production of services and information prevails. Hence the second name of the post-industrial society – information, a characteristic feature of which is knowledge and information technologies combined with high spirituality. Today, in the context of environmental research, man has reappeared at the center of science, and the scientific map of the world gives priority to the humanization of science, because "what a world, such is man, what a man, such is the world." Scientist V. Heisenberg, noting this trend of science, noted that the deeper we look into the Universe, the more we see man in it. Therefore, intelligent, creative human activity is a decisive factor in the development of the biosphere and its transformation into a noosphere, which will satisfy all the material, social and aesthetic needs of mankind. Post-nonclassical science assumes a network of relationships that includes humans. A characteristic feature of post-nonclassical science is its "human dimension". The significance of modern science in Science is characterized by: awareness of the place and role of man in the system Man − Nature − Society. Human awareness of ignorance in any area of existence causes the objective necessity of acquiring and transforming new knowledge about the infinite general harmony with nature.

3. Types and characteristics of scientific research

Fundamental and applied scientific research. Scientific activity is considered intellectual creative work aimed at obtaining and using new knowledge. In practice, various types of scientific activity are used: scientific research; scientific and organizational; scientific and informational; scientific and pedagogical and others. An important task of scientific activity is the formation of a system of knowledge that contributes to the most rational organization of production relations and the use of productive forces in the interests of all members of society. It includes the performance of three social functions: cognitive − satisfying human needs in knowing the laws of nature and society. Since its inception, science has been struggling in the fields of worldview with theology. The main problems are: the structure and origin of the Universe, the origin of life and reason. From a worldview point of view, science as a sum of knowledge gives a scientific picture of the world, as a holistic system of ideas about the world, its properties and patterns of development. cultural and educational − the development of culture, humanization of education and the formation of a new person; practical and effective − improvement of production and the system of social relations, that is, the direct productive force of material production. The methods and data of science are used in the development of programs of special economic development. Therefore, we can say that the concept of science should be considered from three main positions. First, from the theoretical one as a system of knowledge, as a form of social consciousness; secondly, as a certain type of social division of labor, as scientific activity associated with a whole system of relations between scientists and scientific institutions; thirdly, from the position of practical application of the conclusions of science, that is, its social role. It is the material objects of nature that determine the existence of many branches of knowledge, united into three large groups of sciences, which differ in subjects and methods of research: natural sciences (physics, chemistry, biology, geography, astrology, etc.), sciences whose subject is various types of matter and forms of their movement, their interconnections and patterns; social (economic, philological, philosophical, logical, psychological, historical, pedagogical, etc.), sciences whose subject is the study of socio-economic, political and ideological patterns of the development of social relations; technical (radio engineering, mechanical engineering, aircraft engineering), whose subject is the study of specific technical characteristics and their interrelationships. On the border between natural, social, technical sciences, new related branches of science are developing, such as technical cybernetics, ergonomics, bionics, biophysics, technical aesthetics, and others. The Higher Attestation Commission (HAC) of Ukraine, in agreement with the Ministry of Education and Science of Ukraine, the State Committee for Science and Technology of Ukraine, has approved a certain classification of branches of science[5].

New knowledge obtained in the process of fundamental research and recorded on scientific information carriers in the form of a scientific report, scientific work, can be presented in the form of: scientific abstracts; scientific reports at conferences, meetings, seminars, symposiums; course (diploma, master's) works; scientific translations; dissertations (candidate or doctoral); dissertation abstracts; monographs; scientific articles; analytical reviews; author's certificates; bibliographic indexes; textbooks, teaching aids, etc. Science is an integral part of the spiritual culture of mankind. As a system of knowledge, it encompasses not only factual data about objects of the surrounding world, human thought and action, not only laws and principles of studying objects, but also certain forms and methods of awareness. In this way, science acts as a form of social consciousness. Generalizes and investigates the laws of the functioning of science as a system of knowledge and a social institution, carries out an applied systemic analysis of organizational, economic and socio-management conditions for increasing the efficiency of scientific activity processes, a complex of scientific disciplines under the general name scientific knowledge and state scientific institutions and formations. Applied research is research whose results are addressed to manufacturers and customers and which is guided by the needs or desires of clients. Fundamental research is aimed at expanding theoretical understanding and is addressed to other scientists. Modern technology is not as far from theory as it sometimes seems: it is not exclusively the application of existing scientific knowledge, but has a creative component. Methodologically, technical research (i.e. research in technical science) is not very different from natural science, therefore, in the idea of fundamental research as aimed at expanding theoretical understanding, there is no clear division between technical and scientific research. Engineering requires not only short-term research aimed at solving

[5] Генрі Джі Коротка історія життя на землі / пер. з англ. С. Півень. Харків: КСД. 2023. 176 с.

special problems, but also a broad long-term program of basic research in laboratories and institutes specially designed for the development of technical sciences. At present, basic research is more closely related to applications than it was before. The use of basic research methods to solve applied problems is characteristic of the modern stage of scientific and technological development, and the fact that the research is fundamental does not mean that its results are not applicable in practice. However, work aimed at applied goals can be fundamental. Example We can cite as an example the names of specific scientists who were simultaneously or initially engineers: Josiah Willard Gibbs, a theoretical chemist, began his career as a mechanical inventor; John von Neumann, from a chemical engineer, returned to technology through abstract mathematics; Norbert Wiener and Claude Elwood Shannon were both engineers and first-class mathematicians. The list could be continued: Claude Louis Navier, an engineer for the French Corps of Bridges and Roads, also conducted research in mathematics and theoretical mechanics; William Thomson (Lord Kelvin) combined a separate scientific career with a lifelong involvement in engineering and technological innovation; Wilhelm Björknes, a theoretical physicist, became a practical meteorologist. Thus, a good practitioner seeks solutions even if they are not yet fully accepted by science, and applied research and development are increasingly carried out by people with initial training in basic science. Empirical analysis shows that the degree of interaction between academic and industrial research has increased significantly in recent decades, resulting in an increase in the share of academic research in business structures and private universities. Thus, we are talking about a convergence of the academic and technological order of knowledge. The academic order is associated with the processing and creation, theorizing and production of knowledge, in contrast to the technological order, which is aimed at finding, organizing and using already existing knowledge for applied purposes. In the modern information society, the search for existing knowledge necessary for organizing specific actions is becoming increasingly important, and one of the central problems is the problem of presenting knowledge for computer systems, since their users are specialists in various branches of science and technology, and not professional programmers. We will illustrate the change in the ratio of the academic, technological and economic order of knowledge (science, technology and economics) using the example of the inventions of Alexander Stepanovich Popov (1859-1906), Guglielmo Marconi (1874-1937) and Ferdinand Braun (1850-1918). Example In 1895, O. S. Popov used a coherer to record thunderstorms, providing it with a shaker and relay and connecting it to a suspended wire (receiving antenna). At the same time,

G. Marconi conducted a series of experiments using the Riga oscillator, connecting a suspended wire (transmitting antenna) to it. What new did Marconi do, if everything he used in his device was known to him? His contribution should be sought in a different direction. Unlike his predecessors, Marconi managed to come up with a functioning whole. Marconi's own inventive contribution was minimal. He translated scientific discoveries made by others into a useful and potentially profitable device. This was the final step in the line of scientific progress, which originated with Faraday, Maxwell and Hertz, in the sense that it reached the stage of commercial exploitation. Before that, the transfer of new knowledge took place exclusively in one direction – from science to technology and then to commercial use, but now the opposite flow of information was born. Marconi, aiming to achieve an ever-increasing distance that was less directly related to scientists, went beyond the sphere of knowledge where the science of that time could help him, and began to investigate problems for which science had no solution. In addition to using the already existing knowledge for practical purposes, Marconi, in a kind of feedback process, began to generate problems that science had to solve, and data for the rationalization of science itself. As an entrepreneur in the field of technology and a rationalizer, Marconi reached the problem area in which science had no ready-made answers. It was the feedback process, the generation of new information from the sphere of experience, which stimulated new scientific research. In the same way, A. S. Popov experimented in Russia with the transmission of signals without wires, but did not find sufficient support from the then officials. Only later was the importance of his discovery for the country correctly assessed: in Soviet Russia, both the radio industry and theoretical and applied research and development in this area received really serious state support. Marconi used many of the results of other researchers and inventors for his work and demonstrated commercial acumen. But very soon it turned out that it was impossible to advance further without obtaining new knowledge about the physical processes occurring in a new technical device. Ferdinand Braun was able to do both, who conducted this kind of research and patented the invention based on it. It becomes obvious that for the introduction of new technology into life, not only discoveries, inventions and their patenting play an important role, but also their adaptation to the industrial production of new technology, as well as the distribution of the newly created product (innovation) on the market. This ability to unite all these areas was demonstrated by F. Braun – a brilliant theoretical physicist and at the same time a practitioner. He not only timely and competently patented and protected his inventions, but also created an enterprise to promote his inventions and patents to the market, which later merged with other firms and began to produce products under the name "Telefunken". The historical example we have considered very clearly shows how important it is not only to discover and invent, not only to establish priority and patent, but first of all to make the invention a public property through the formation of appropriate economic structures. Today, when not only finished products, but also knowledge and know-how enter the market, this is especially significant.

4. Research activities of students

Research activities of students are one of the most important means of improving the quality of training and education of specialists with higher education, capable of creatively applying the latest achievements of scientific and technological progress in practical activities. As is known, the economic and social reforms being implemented in Ukraine are significantly changing the nature of the work of specialists in the service sector. In accordance with this, the requirements for training personnel are changing accordingly. Among the most important are the requirements for the development of a creative, initiative specialist who has organizational skills and the ability to direct the activities of his unit to improve the technological process by introducing new achievements of scientific and technical thought into practice. An indispensable condition for fulfilling this requirement is the wide involvement of students of higher educational institutions in research work, their direct inclusion in the sphere of scientific life. Since the main task of higher education institutions is to train specialists for the national economy, the most important (and characteristic of higher education) issue of implementing R&D was and remains the question of its impact on the educational process. This is the main feature of the organization of science in higher education. Experience shows that the development of scientific research directly affects the quality of the educational process, since they change not only the requirements for the level of knowledge of students, but also the learning process itself and its structure in higher education, increasing the degree of preparedness of future specialists, their creative practical horizons. The development of science in higher education involves improving the quality of training specialists who, in turn, are able to independently solve serious scientific problems after graduation, to keep up with advanced ideas in the theory and practice of national economy management in a market economy. Therefore, it is in an educational institution that it is important to instill in students a taste for scientific research, to teach them to think independently at this stage. Thus, the development of science in higher education not only changes the content and meaning of academic disciplines, but also suggests new forms and methods of conducting the educational process. The results of scientific research are used in new courses, lectures and practical (seminar) classes. As practice shows, involvement in scientific work makes the disciplines studied objective for students, stimulating their assimilation. Moreover, scientific research activity is an organic part and a prerequisite for the successful work of higher educational institutions. Students not only receive the latest scientific and practical information from teachers at lectures and seminars, laboratory work and industrial practices (especially senior students), but also participate in scientific research. Therefore, increasing the efficiency of university scientific and research works, involving students in their implementation also increase the quality of training of highly qualified specialists. Due to this, university science has the opportunity to rejuvenate scientific personnel, since the influx of young scientists is carried out constantly. This feature gives great advantages to higher education both from the point of view of the development of research itself and from the point of view of training scientific personnel. Therefore, the specifics of the work of higher educational institutions require not a simple, but an organic combination of educational and research work of teachers, postgraduates and students. Typical in this field are the integration and further specialization of scientific activity and acceleration of the pace of its development. At the same time, the presence of departments and specialties of different profiles and directions creates the opportunity to conduct complex research. In higher educational institutions, scientific research at the junction of sciences (for example, economics and management, accounting and economics, marketing and management, tourism and hospitality) is often developed. This gives a certain advantage to scientific research, since with all the complexity and diversity of the modern world, multifacetedness and complexity play an increasingly important role. As is known, institutes and universities have the opportunity to create collective forms of various units – such as inter-departmental and inter-faculty associations, the formation of joint groups to carry out this or that research work, etc. Purposeful implementation of scientific research in circles of the student scientific society, postgraduate students and young scientists in a higher educational institution contributes to the formation of a comprehensively developed personality of a specialist, scientist. The scientific work of students is organized by the graduating profile department, which is the basic methodological center for scientific work with students. To manage scientific research, it appoints a scientific supervisor (one for 6-7 students). The scientific and research activity of students includes two interrelated areas: teaching students the elements of research activity, organization and methodology of scientific creativity; scientific research carried out by students under the guidance of professors and lecturers on a general departmental, general faculty or university scientific problem. The content and structure of students' scientific research activities ensure the consistency of means and forms of its implementation in accordance with the logic of the educational process, determines its continuity from course to course, from department to department, from one discipline to another, from one type of activity to another. The gradual increase in the volume and complexity of knowledge, skills, and abilities acquired by students in the process of performing their scientific work ensures the solution of the following main tasks: the formation of a scientific worldview, mastering the methodology and methods of scientific research; providing assistance to students in accelerated mastery of the specialty, achieving high professionalism; developing creative thinking and individual abilities of students in solving practical problems; instilling in students the skills of independent scientific research; developing initiative, the ability to apply theoretical knowledge in their practical work; expansion of the theoretical horizons and scientific erudition of the future specialist; creation and development of scientific schools, creative teams, education of a reserve of scientists, researchers, and teachers in the university. The organizational structure of scientific and research activities in a higher educational institution can be presented in the following form: vice-rector for scientific work; council for scientific and research activities of students of the institute (university) (RNDS); council of the student scientific and creative society of faculties; student scientific and creative societies of departments. Scientific management of the student scientific and creative society is carried out by a scientific director, who is elected by the Academic Council of the higher educational institution. The chairman and members of the council are appointed by orders of the institute, faculty. The scientific and research activities of students of a higher educational institution are carried out in the following main areas: scientific and research work, which is a component of the educational process and is mandatory for all students (writing essays, preparing for seminar classes, preparing and defending course and diploma theses, performing research tasks during the period of industrial practice on behalf of enterprises, etc.); scientific and research work of students outside the educational process. It includes: participation in scientific circles, performing self-financing scientific works within the framework of creative cooperation of departments and faculties; work in student information and analytical, legal consultations, tourist companies, translation agencies, etc.; advertising, lecturing activities; writing theses of scientific reports, publications, etc. In coursework in general theoretical and special disciplines, students use elements of scientific research in the form of scientific research, prepare a literature review and develop proposals containing elements of novelty on the topic of the work; summarize advanced practical experience, apply economic and mathematical methods, computer and organizational techniques, information technologies. The problems of scientific research are reflected in the coursework of students, must find their continuation in the diploma work, and also be part of the scientific subject of the relevant department. Each student during educational and industrial practice, in addition to the general task provided for by the practice program, performs research tasks in accordance with his specialty, which are issued by the graduating department. The completion of the task is reflected in the diary in a separate section of the report on the completion of the practice and can be used when preparing reports at conferences, information seminars, when writing course and diploma works. The thesis must contain elements of research search, which characterizes the student's ability and readiness to theoretically comprehend the relevance of the chosen topic, its scientific and applied value, the possibility of conducting independent scientific research and applying the obtained results in the practical activities of the base enterprise, based on the materials of which the research was carried out. Therefore, the topic of the thesis must be closely related to the topic of the department's research work, to the interests of the enterprise on the basis of which the student is performing the thesis, be part of the economic research topic of the department, the faculty of the higher educational institution.

5. The future of modern nakiya in Ukraine

In the early nineties, when Ukraine had approximately the same level of provision with researchers as the leading countries of Europe, the International Monetary Fund (IMF) strongly recommended that it reduce its scientific potential by three times. Such a recommendation was quite understandable from geostrategic considerations in the light of the then understanding of the problems of its own security by Western countries. After all, our state, at that time still considered a significant part of the "post-Soviet bloc", mutual understanding between Ukraine and Russia did not cause serious doubts, and everyone knew that Soviet science, including Ukrainian science, largely worked in the interests of defense. Therefore, weakening this science, distracting domestic researchers from problems related to military affairs, was considered one of the directions of guaranteeing security. To accelerate such distraction, an international fund with the beautiful name Ukrainian Scientific and Technological Center (USTC) was even created, to which, of course, some Ukrainian scientists cannot but be grateful for support in difficult times, but which also played a noticeable role in stopping research, the results of which would be very useful to us today. It also contributed to the fact that Ukraine ceased to be a noticeable competitor to world arms manufacturers. The recommendations shocked Ukrainian scientists, but were readily accepted by the authorities: they not only undertook their implementation, but also, like an overzealous supplicant who bowed without sparing his own forehead, significantly overfulfilled them – the number of researchers in Ukraine decreased by almost 5 times as a result of almost constant funding cuts and the so-called "optimization" of scientific institutions.

One of the most important indicators by which experts compare the capabilities of different countries for the innovative development of their economies is the number of researchers per million population. In 2015, on average across EU countries, this figure was 5,350 people. At the same time, the leadership of the European Union, having analyzed the possibilities of accelerating innovative development, came to the conclusion that this was not enough and set the task of attracting at least 3 million additional researchers to European science. However, the dynamics of the human resource potential of Ukrainian science is opposite to the European and global trends in its development, the number of researchers per million population is 2.6 times lower than in the EU. In the total number of employed population of Ukraine in 2015, scientists accounted for only 0.57%, and in 1990 – 1.16%. That is, we have reached the level of the least developed countries in terms of science, such as Romania (0.46%) and Cyprus (0.71%), in Finland and Denmark – 3.2%, in Switzerland – 2.66%, in Norway – 2.56%, in Slovenia – 2.27%. Moreover, in recent years, it has been growing quite intensively in the mentioned countries. On average, this indicator in the EU is 5-6 times higher than in Ukraine. Almost all of our neighbors, even those whose science was previously significantly inferior in authority to Ukrainian science – Turkey, Poland, Romania – are constantly increasing their scientific potential (not to mention the unprecedented rate of its growth in countries that set themselves the goal of catching up with economically developed competitors – in Japan, South Korea, China, etc.).

But was it easier, for example, during the Patriotic War with fascist Germany? During that extremely difficult – both in human terms and in economic terms – war, spending on science in the USSR was increased by 1.2 times. And immediately after the end of the war – in 1946 – the salaries of scientists were increased by 5-6 times. But is it possible, in principle, to “rapidly increase” it?! If a qualified worker can be trained in 1…2 years, a teacher or engineer in 4-6 years, then to form a full-fledged researcher – much more. To create a productively working scientific team, even decades may not be enough. After all, its capabilities are determined not only by the personal qualities of individual employees, but also by the rational distribution of role functions and the harmonious combination of researchers of different generations. A feature of science is that the process of forming a researcher takes place in science itself – in the scientific team, so its personnel is replenished only due to the arrival of young people. Cases when people of mature age enter science, of course, do happen, but this is a rarity. Despite all the hardships, the arrival of young people to science until recently even increased somewhat, which was a reason for some restrained optimism about the possibilities of its revival in the future, despite the fact that a significant part of younger and middle-aged researchers, having obtained a certain qualification, left it in search of a more decent payment for their work. But after 2012, the decline in the prestige of the scientific profession and its lack of prospects in the eyes of young people prevailed: its arrival in science began to fall.

If nothing changes in the policy of our government towards science, and the dynamics of its human resources continue to show the same trends that we observed during 2010-2015, by 2025 the number of researchers in Ukraine will decrease by another 3.5 times compared to 2015 (i.e., there will be 7.5 times fewer of them than in 2005, and at least 20 times fewer than in the early nineties). The above indicators of the country's innovative capabilities will also fall by the same amount. If we allow this to happen, then this can already be considered the final completion of the liquidation of Ukrainian science and any hopes for a truly innovative development of our economy in the modern world. It is clear that such neglect of the fate of future generations cannot be allowed. To prevent this from happening, it is necessary to sharply improve the social status and working conditions of scientists so that the influx of young people into science begins to grow significantly, and researchers are not forced to flee science in search of more decent pay.

By implementing a policy to support science, the state will not even be able to reach the level of human resources in its science in 2010 in 20 years. Further searches for more effective options led to the conclusion: in order to approach the indicators of human resources in science commensurate with current European standards by 2035, Ukraine needs to at least double the number of young people entering science every 5 years. This is evidenced by the results of the calculation of the probable evolution of the human resources potential of domestic science, for the case when such a policy begins to be implemented not now, but only starting from 2020.

The situation in domestic science has already reached such a catastrophic level that achieving the desired indicators is practically impossible for at least 10 years (and therefore it will cost even more, and achieving the necessary goal will be even more problematic). Thus, extraordinary measures are urgently needed to support the scientific potential of the state –

measures aimed at its revival, not at survival, and immediately – otherwise survival may not work out. Ukraine has not yet seen such measures, and some may think that they are impossible at all. However, if you look closely at what is being done to increase the human resources potential of science in countries that really want to break out of the "third world" and become leaders in economic development – for example, China or India – it is not difficult to see that for this purpose they really go to extraordinary measures and expenses: enormous funds are spent on the return of scientists who have left the country and are working abroad, on luring young foreign researchers and students. The salaries of scientists in China have increased 24 times in 15 years. India, which is not at all rich, has even built an entire city for researchers and developers of IT technologies.

Is this a manifestation of special sympathy for science and scientists, or heartfelt kindness to them on the part of the authorities? Not at all – it is simply a pragmatic understanding that without science the country has no future. At the same time, the Ministry of Finance considers it a big step forward in the direction of supporting science, the fact that its funding has been constantly reduced in the state budget since 2010. Every year, the Ministry of Education and Science introduces more and more obstacles for young researchers, which hinder and slow down the replenishment of science with young people. This is motivated by the desire to improve the quality of training candidates of sciences and once again reach the level of "European standards", naively interpreted – almost with the exact opposite. For example, the degree of Candidate of Sciences (in the Western version – Phd – Doctor of Philosophy) in most Western countries was never considered something very unique. It was seen as confirmation that a young scientist had already proven that he could conduct scientific research. The degree of respect for the one who received it, and the degree of consideration in deciding his future fate, was determined (and is still determined) by the institution that awarded it: whether it was a reputable institute or university, or a little-known provincial institution.

Most often, nothing too big is made of the defense process itself. Let’s remember what such a defense was for the young Albert Einstein – he brought a small notebook to the university, in which the essence of his work was outlined. The rector appointed three professors, whom he instructed to get acquainted with it. They met with the author and, having talked with him, decided that the work was interesting, which means that he could be awarded the degree of Doctor of Philosophy − that’s all. In our country, this act has turned into a ritualistic rite, which is surrounded by hundreds of bureaucratic requirements and rules, is accompanied by the formation of a huge number of papers, the collection of numerous signatures, seals, etc.

And at the same time, with the active support of the media, the idea is persistently repeated that the level of requirements for dissertations is still insufficient and needs to be increased.

Interestingly, this is not a specific feature of the domestic bureaucracy, it is the result of a pattern that researchers have recorded all over the world: any attempts to eliminate the shortcomings of the bureaucratic management system using bureaucratic methods always lead only to their strengthening. After all, we have already reached a level where the same Einstein would hardly have broken through into our candidates of sciences, not to mention being elected a professor – after all, for example, he did not speak English very well at that time! (Princeton University went for it, not knowing our rules and the fact that taking into account the grandiose revolution in physics made by his work is not provided for in the instructions of our bureaucrats!). Not only does all this paperwork take up an extremely long time for both the applicant for a scientific degree and many participants in the procedure for preparing and conducting the defense, in Ukraine it has also become the basis of a mechanism for unscrupulous robbery of young scientists – the money they are forced to spend to defend their dissertation has become simply sky-high. At the same time, if once opponents were paid a certain amount for their work by an institution with a specialized academic council, then in the conditions of chronic underfunding of institutes, everyone was forced to agree that all this should be done at the expense of the one who is being defended.

6. Scientific infrastructure of Ukraine during the war

The war caused enormous damage to the scientific infrastructure of Ukraine – scientific research institutes, universities. However, great opportunities may await it ahead, which few countries are capable of realizing. Over the past few centuries, science has been a life-giving source of knowledge that has driven the progress of mankind in all areas − from medicine to engineering. And although some scientific discoveries serve vile purposes, a noble scientific culture not only produces valuable know-how, but also improves the environment in which these discoveries are used for various purposes. Ukraine is no exception to this, and the history of its science is rich and outstanding. The National Academy was founded on the basis of the Ukrainian Scientific Society in Kyiv a few months before the war with the Soviets in 1917 – a war of independence, after which Ukrainian science and all of Ukraine drowned in the Soviet experiment. The National Academy of Sciences of Ukraine appeared in its current form in 1994.

Another bastion of Ukrainian science has always been the All-Ukrainian Society "Prosvita" named after Taras Shevchenko, founded in 1873, which now has branches all over the world. Over the past centuries, Ukraine has experienced many changes due to various geopolitical circumstances, but its scientific roots have stood up against all the currents that swept through it and raged around it.[6]

Let's leave history for a moment. What does the future hold? Perhaps one of the most interesting scientific potentials of Ukraine comes from its geographical location on the eastern flank of the West, on the western flank of Eurasia, and on the northern flank of the Global South. Here it can act, so to speak, as a scientific trade route for the creative exchange of ideas. Is it possible in Ukraine to build bridges across the two huge chasms of the modern world – between East and West and between North and South? This simple example clearly demonstrates the enormous intellectual potential of Ukraine, and to realize it, a free culture is needed, which is not constrained and not threatened by the spread of any ideas. Ukraine has both the necessary elements for this – the ability to work as a transmission line between the Western and Arab worlds and a culture of openness that brings these worlds closer together.

Ukraine understands this role well, its culture is diverse and multifaceted. Why not become a connecting link for the exchange of scientific ideas and innovations in a world dependent on technology, where effective scientific cooperation can at least partially solve the problem of a significant difference in living standards between the North and the South and reduce tensions between the East and the West? How to achieve this? Through scientific institutions in molecular biology, astrophysics, medicine, space science and many others, which will send students, postgraduates, candidates and doctors of sciences from different geographical regions, with different languages and cultures. Working together in this uniquely neutral geographical location, they will produce ideas that will revolutionize science. Here, these institutions will gain strength to cast a wide geographical net over Ukraine's thriving IT sector (which itself is a product of Ukraine's first computer schools, by the way).

Of course, the idea of international scientific cooperation is not new. There are a huge number of laboratories in the world that employ representatives of different cultures. But Ukraine's location is particularly well-suited to creating organizations that are not simply Western institutions with scientists from the East, or Eastern institutions with some Western scientists. In this "crucible," a true fusion of cultures can be born, where ideas that are independent of anyone will bubble up. Such organizations can be both state and non-state. And while we are nurturing ambitious ideas, such a bridge between the West and the East could put an end to other

[6] Браян Грін До кінця часів / пер. з англ. С. Півень. Харків: КСД. 2024. 432 с.

disagreements. Since the Islamic world surrendered its dominant positions in mathematics, astronomy, and medicine to the West in the 17th century, there has been a scientific gulf between them. Could Ukraine be a catalyst and a conduit for the renewal of scientific cooperation and a fusion of ideas stronger than cultural and religious differences?

There is another facet of Ukraine's scientific potential – its turbulent past. Stability over centuries is always good for peace and predictability in society, but as a result, the desire for novelty disappears. Ukraine has the freedom of movement born of the kaleidoscopic changes in its history. Will it lack the energy to revive and build academies, institutes, and research centers with different cultures that would be the envy of the whole world? If such a vision were to be realized, the effect would be enormous. We would be able to extend our scientific tentacles around the world and create a truly global scientific community. Here comes the elephant – funding. All of humanity benefits from improving scientific culture in any country. If science works only for war or declines, it is bad for an open society. Where science has declined, there is no place for objective knowledge, independent institutions, or democracy. Therefore, it is in everyone's interest to help finance and support the reconstruction of science in Ukraine.

There are also broader, political aspects. Strong science does not exist only in countries of liberal democracy – a dedicated scientist can write an excellent scientific paper even under the worst totalitarian regime. However, I believe that the best conditions for scientific creativity exist in a society where different, even opposing ideas, can be expressed and implemented as fully as possible in all spheres of life, because this is what the culture of scientific work is all about. Healthy science brings energy, rationality, and strength to open decision-making processes. Freedom in society and freedom in science are a powerful symbiosis.

CONCLUSIONS

New scientific processes will quite possibly revolutionize various industries. In fact, a fantastic future is associated with the development of protein and genetic engineering, bioelectronics (biosensors, bioelements, genetically modified foods), with the production of new plant growth stimulants, highly effective drugs. On an industrial scale, such science includes, on the one hand, industries in which traditional methods are constantly being updated, and on the other, new industries in which not only man plays a major role. Among the first in the chemical industry is the synthesis of artificial products, polymers and raw materials for various industries, in the energy sector − the production of methanol, ethanol, biogas and hydrogen, in the field of biometallurgy − the extraction of metals. The second group of industries includes product production (cultivation of yeast, algae, bacteria to obtain proteins, amino acids, vitamins, and to use their enzymes), increasing agricultural productivity (cloning and selection of plant varieties based on tissue and cell cultures, production of bioinsecticides); pharmaceutical industry (development of vaccines, synthesis of hormones, interferons, and antibiotics); environmental protection and reduction of its pollution (wastewater treatment, processing of household waste, production of compost, as well as the production of compounds that are broken down by microorganisms).

ABSTRACT

The biological diversity of plant cell and tissue cultures opens up interesting prospects for studying new useful compounds. Due to the terrible ecological situation on planet Earth, for example, the city of Naples (Italy) is drowning in garbage, every 10th inhabitant of this city has cancer, and 100 million tons of garbage are generated there per year. What is being done in Eastern European countries? For comparison, 10 million tons of household waste accumulates in Ukraine per year. Due to such significant garbage dumps, factories do not have time to process it, in addition, plastic bags and plastic containers when burned form dioxin − a poison that causes cancer. Each person throws away up to 100 kg of plastic bags and 100 kg of plastic containers per year, few countries can cope with such a large amount of garbage. In the Caribbean Sea, there are 3 islands of garbage the size of the territory of Ukraine (603 thousand sq. km). These islands drift between California and Japan, contaminating the sea water with the same dioxin, which is then consumed by sea creatures (fish, crabs, shellfish, etc.) and all this ends up on the table of the consumer a human. All these problems will soon be 100 years old and one could say that the so-called technical revolution or scientific progress of mankind has brought more harm than good, since the amount of waste generated due to this is constantly growing, but there is hope that the light at the end of the tunnel will still shine.

The success of such a scientific attitude extends to the international relations of any state, and again it is in the interests of all states everywhere to promote sound science as much as possible. One way to achieve this is to create an International Science Foundation that would provide large-scale technical and financial support to countries seeking to build and reform their scientific institutions. This foundation could make them as independent as possible from the state and ensure proper financial reporting according to uniform standards. In the absence of a global architecture for supporting science, individual states and existing blocs should materially support Ukraine in its efforts to rebuild its science. Ukraine could attract scientific

support, personnel and finances from all over the world. Ukraine, located at the junction of major political and cultural tectonic plates, could make the most of all opportunities, receiving funding from all corners of the world to increase its scientific portfolio. In its scientific aspirations, Ukraine should not be too modest and defer to authorities. Occupying a geopolitically advantageous position in the world, with a fundamentally liberal democratic system and the energy of a new self-awareness, it has every reason to occupy a prominent place in this world. Now, through the smoke of war, such ideas may seem like fantasies far from reality, but still one should look with great optimism at the potential of an independent-minded, scientifically motivated Ukraine.

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