https://doi.org/10.15407/scine20.02.024

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HISTORY AND SOCIOLOGY OF SCIENCE DURING THE CRISIS AND TRANSITIONAL PERIODS OF SOCIAL DEVELOPMENT

Introduction. *During critical or crisis periods of social development, the need to search for forms of interaction between science and society, to solve problems in organizing research activities and researcher individual work, and to identify scientific problem to be solved for overcoming social challenges becomes especially relevant. It is reasonable to use the heuristic possibilities of studies in history and sociology of science and the experience gained.*

Problem Statement. *Rethinking the subject areas and tasks of the history and sociology of science, which are proposed to be considered not only a historical description of the impact of social processes on the development of science, or science on society, but also knowledge that allows identifying the mechanisms for enhancing the development of science and society through mutual understanding, inclusive and sustainable growth, innovation culture.*

Purpose. *To define the heuristic potential of history and sociology of science for finding ways to overcome the challenges related to interaction between science and society during crises associated with the practice based approach of modern science; urgent problems of researcher professional activity; social aspects of the project method of organizing scholarly research; issues of science communication with society and government in times of pandemic and war.*

Material and Methods. *The research is based on the comprehensive use of general scientific principles of historicism, objectivity, reliability, integrity, systematic approach, and representativeness.*

Results. *It has been substantiated that studying history and sociology of science enables identifying problems and mechanisms of enhancing the development of science and society through mutual understanding, inclusive and sustainable growth.*

Conclusions. *For the successful innovation-driven development of Ukraine's economy it is necessary to focus primarily on developing the innovation culture of society and implementing science-centric government policy. The social and humanitarian sphere should become one of the priority areas of innovation in Ukraine.*

Keywords: history of science, sociology of science, social development in times of crisis, research project, research culture, science communication with society and government, innovation culture of society.

Citation: Ryzhko, L. V., Lytvynko, A. S., and Zhyvaha, O. V. (2024). History and Sociology of Science During the Crisis and Transitional Periods of Social Development. *Sci. innov.*, 20(2), 24—37. https://doi.org/10.15407/scine20.02.024

Science and technology as a socio-cultural phenomenon have a complex impact on social life, contributing to its technical, economic, and social development, establishing education system and scientific worldview of the population. The principal factors of growing interest in researches on history and sociology of science are awareness of the social essence of cognitive activity, importance of science for social development, the role of R&D potential for the economy and competitive manufacturing, and also dependence of science on the government and public support. The relevance of these issues is particularly evident during transition or crisis periods of development and is marked by finding forms of interaction between science and society, solving the problems of organization of scholarly research activities and scientist's individual work, development of approaches that are required to overcome social challenges, etc. For example, the issues related to communication between science and society, science and government, and public trust in science increased significantly during the pandemic. During wartime and revival, the following issues are of paramount relevance: awareness of the role of science as a systemic factor in formation and development of the state, critical thinking skills formation, scientific worldview and an understanding that only the form of scientific knowledge inherent in objective and subjective ways of consideration of phenomena, which in a long term will contribute to overcoming humanitarian challenges, improving the efficiency of science in social practice, recovery of economy, socio-cultural, humanitarian, defense and security sectors, promotion of democracy.

During development of scientific systems of industrial and post-industrial society, it becomes important to define the role of socio-cultural factors in genesis and development of scientific knowledge, the importance of science for society's evolution, improvement of material production, labor productivity and well-being of mankind. Furthermore, at the beginning of the 20th century researchers, such as M. Weber, J. D. Bernal, J. B. S. Haldane, J. Needham, L. Znaniecki and others, followed the principle of autonomy and self-organization of scientific area, defined principles of science's existence while cooperating with other social institutions. Further researches in the 1940s—1970s, including T. Parsons, N. W. Storer, R. K. Merton, B. Barber, J. R. Cole & H. Zuckerman, J. R. Cole & St. Cole, D. J.de S. Price etc., considered science as a collective activity that includes various types and forms of cooperation, which are regulated by the corresponding norms of ethos and enable the implementation of self-management and self-organization principles into scientific area.

The complement to normative sociology that focuses on institutional aspects became cognitive sociology (1970s—1990s). Its objects are discourse, rhetoric, interpretation tools that are used by researchers for persuading others with their opinions. The studies were conducted at a micro level (as a case study) by R. Whitley, M. Mulkay, N. Gilber & M. Mulkay, R. Turner, B. Latour & St. Woolgar, K. Knorr.

During the last quarter of the 20th century and later, these situational concepts, opposed to cumulative, linear models of scientific development, are also included in the history of science and become an integral part of modern studies on social history of science V. M. Horobets [1], O. M. Bogolyubov [2], O. P. Ogurtsov [3], O. O. Potishchuk [4]. Owing to the social history of science, it was possible to overcome the constraints of the general history of science, which was focused on cognitive history, adding numerous aspects of public life that contribute to obtaining of scientific knowledge — interaction between scientists and governing structures, communication in research team, socio-political processes, and cultural significance of scholarly research. Thus, to the "history of ideas" is added the "history of people" L. O. Shashkova [5]. T. Kuhn clarifies the concept of paradigm and introduces definitions of "microparadigm" and "microcommunity" in his work "Thinking About Paradigms" (1974) not coincidentally [6].

Ukrainian scientists in the field of general and social history of science are V. V. Danylevsky,

K. K. Hryenov, Y. Z. Shtokalo, O. M. Bogolyubov, V. M. Horobets, L. O. Shashkova, L. M. Byesov, Yu. O. Khramov, O. M. Korniyenko, V. S. Savchuk, V. A. Vergunov, V. M. Sklyar, O. Ya. Pylypchuk, V. P. Kotsur, N. I. Kotsur, A. S. Lytvynko, L. V. Ryzhko, V. M. Gamaliya, O. O. Potischuk.

In the late 20th — early 21st centuries, sociologists pointed out the role of network activity due to the development of information and communication technologies. According to K. Knorr-Tsetina, knowledge society is characterized not only by the presence of more experts, technological and information infrastructures, but above all by the fact that knowledge cultures are integrated into fabric of the society, all social and economic processes are produced by knowledge, and functioning, generating knowledge. Therefore, knowledge society can be better described by sociology than by economics [7, p. 278]. These theoretical reflections were developed in number of studies concerning the influence of information and communication technologies on a practice of scholarly research and infrastructural changes in science, particularly on transformation of the system of science communication, intensity of information flows, changes in forms of leadership and assessment of contribution into science D. W. Braben [8], E. Forsberg, L. Geschwind, S. Levander, W. Wermke [9], K. Bjorkdahl, A. Santiago, F. Duharte [10], transformations of scientific ethos L. Ryzhko, V. Onoprienko, T. Bessalova [11], B. J. Macfarlane [12], V. Onoprienko [13], changes in the principles of interaction between science and society, also education A. T. Petricini [14], Carmen Martinez-Vargas [15], S. Hennessy [16], M. Bucchi, B. Trench [17], the impact of technologies on social processes S. Maasen, S. Dickel, C. Schneider [18], K. Rommetveit [19].

G. M. Dobrov pointed to the risk of underestimating individual peculiarities and psychological features of every person, who work in science. Concrete study of these features is a task for sociologists, psychologists and scientists of science [20, p. 176—177]. In this context, of great importance is addressing to the history of science, particularly to scientific biography studies, identification and analysis of scientific schools operation: O. O. Bogomolets [21], M. Born [22], V. Ostvald [23], D. D. Zerbino [24], T. Kuhn [25], I. Lakatos [26], S. R. Mikulynskyi, M. G. Yaroshevsky [27], V. P. Kartsev [28], Yu. O. Khramov [29, 30] et al.

B. A. Malitsky associates current tasks of science of science with the need for a principally new analysis of science, which would "focus fully on its modern practical function. This applied function finally transforms science into the subject of social management and respective government policy" [31, p. 4].

Transformation of science into an effective tool for solving economic and social problems has formed demand to rethink the subject areas and tasks of history and sociology of science, which should be considered not only a historical description of the impact of social processes on scientific development, or science on society, reviewed together with internal logic of scientific directions development, but also knowledge that enables identifying the mechanisms of enhancing the development of science and society through mutual understanding, inclusive and sustainable growth, innovation culture.

The purpose of the research is to define the heuristic possibilities of history and sociology of science for emerging ways to overcome the challenges related to interaction between science and society during crisis, associated with the practice based approach of modern science; urgent problems of scientist's professional activity; social aspects of the project method of organizing scholarly research; issues of science communication with society and government; times of pandemic and war.

The research is based on the comprehensive use of general scientific principles of historicism, objectivity, reliability, integrity, systematic approach and representativeness, implemented through general scientific (analysis, synthesis, induction, deduction, analogy, classification, typology, system-functional approach, etc.) and basic general historical methods of scholarly research (historical-compa-

rative, historical-genetic, historical-typological and historical-systemic).

Combining several research methods mentioned above, beyond systematization of historiographical sources, allows studying the subject of research most fully and thoroughly, making comparison between the research works of Ukrainian and foreign researchers and enables generalizations, conclusions, and recommendations regarding the importance of history and sociology of science and technology during crisis and transitional periods of social development.

Using methodological tools set out above, we will review the sources related to the problems of science during crises and transitional periods of development, including inputs from international organizations (UNESCO, UN, OECD, etc.), and will provide recommendations to address the challenges of professional scientific activity in a pragmatically oriented science, which contribute to the development of society's innovation culture and implementation of science-centric government policy.

FEATURES OF THE MODERN SCIENTIFIC AREA

The UNESCO report said: «Science has become synonymous with modernity and economic competitiveness, even with prestige" [32, p. 3]. Researchers have noted a special feature of modern science, which is its orientation towards solving the problems of social and personal life, development of industrial and information technologies, overcoming different social challenges and crises.

The objectives of R&D is often determined in the terms that have value: sustainable development; "smart" technological systems; intellectual energy; ecologically safe power energy; "green" technologies, etc. Scientific tasks are most often directed to the needs of specific regions and consumers of scientific products, therefore there is a "contextualization of science" according to the definition of L. K. Hessels and H. van Lente [33]. The social orientation of modern science is marked by involvement of potential consumers or customers of scientific product to the formulation of research tasks and assessment of the results. This trend of modern science H. Novotny, P. Scott, M. Gibbons called a transition to "socially distributed knowledge production" by "transgressive" institutions [34].

There are changes in professional scientific environment. Researchers are stating the transformation of the Mertonian norms of scientific ethos due to the influence of social needs and competitive market environment. For example, J. Ziman assumes that the basic principles of researches aimed at practical purposes are "ownership", "locality", "authoritarianism", "aiming at the need of customer", "expertise" [35]. Thus, according to B. Macfarlane and M. Cheng, capitalist principles become leading in science: individualism, particularism, interest [36].

The stated above understanding of the characteristics of modern science is incomplete, because it is based on the principles of technocratism and does not take into consideration the uneven R&D development of countries and regions. The United Nations report [37] puts the question of the global impact of the uneven technology development on the social sphere, particularly on growing of inequality. The issue of inequality is multifaceted: geographically: between residents of cities and villages, center and periphery, countries, regions, parts of the world; by spheres: social, economic, ecological and digital. There is also inequality of opportunity and inequality of outcomes, thus as noted in the report, growing of inequality occurred with each wave of science progress. Countries with advanced R&D potential are evermore running ahead of less developed ones, and inequality is turning into a "gap". Whilst R&D development is almost the only way to overcome economic backwardness and establish better living conditions. Therefore, developing countries cannot miss a new wave of R&D progress. Whole society, however, would have benefited if we reach balancing innovation with equity in pursuit of the Sustainable Development Goals [37, p. XIII]. Technologies alone are value-neutral, and it always

depends on people whether it will bring benefit or harm. In times of crisis, the emerging technologies are used to improve people's lives and protect the planet. The UN notes: "During the COVID-19 pandemic, artificial intelligence and big data have been used for mass examination of patients, monitoring outbreaks, tracking disease cases, predicting disease progression, and assessment of infection risks [37, p. 71]. Thus, technologies enable the implementation of social, political and environmental initiatives. However, for this technological development need to be based on humanitarian, social, ethical values and ideals, to support the sustainable development goals, to be equitable, transparent and inclusive.

Social processes nowadays cease to be external factors for scientific development, but are interwoven into all stages of establishing research process: in the problem statement, setting the tasks and assessment of the results. They put questions that actualize social research in scientific area, equitable use of scientific developments for the benefit of society. However, this raise issues of public understanding and trust in science, since on the one hand, the complexity and interdisciplinary nature of modern scientific research results in gap between scientific and common-sense knowledge, on the other hand, technologies are often ambivalent and carry potential risks. The large-scale sociological surveys are usually conducted for studying these issues. For example, the US National Science Council every two years publishes reports on public perception of science and technology, public understanding of scientific logic and the essence of research work, defining popular means of receiving information about science, awareness and perception of specific scientific topics, including those of urgent interest. The studies concerning public understanding of science, technology, ethical problems of new technologies, mass media coverage of scientific and technological development are conducted also in the European Union countries. The CONCISE project was implemented in the EU during December 2018 — January 2021; the aim of the project is to conduct a pan-European debates on science communication involving the wide range of stakeholders, from mass media to politicians, from scientists to business companies, from scientific communicators to civil-society institutions regarding attitudes towards vaccines, usage of alternative medicine, genetically modified organisms (GMOs) and climate change [38]. The British company Wellcome trust regularly investigates attitude of young people and adults towards science, academic careers and science education. The China Research Institute for Science Promotion (CRISP) monitors scientific competence of citizens.

The researches concerning similar issues are also conducted in Ukraine, but less intensely. Since the 1990s the Institute of Sociology of the National Academy of Sciences of Ukraine has conducted annual monitoring surveys concerning the prestige of professions, including profession of a scientist, and understanding the role of science in society.

The results of the earlier observations on the characteristics of the modern science and its place in public life might become an idea of the need for a new agreement between science and society. According to L. Hessels, H. van Lente and R. Smits [39, p. 387—401], a new agreement should outline the tasks for scholarly research, that is, to determine which knowledge will be considered to be relevant at the moment. It will give an opportunity to justify the expediency of public support for science and establish an enabling environment for scientific work. In that context it is important to put the issues concerning interaction between science and society, as well as the principles of work in research teams and research culture.

PROBLEMS OF IMPLEMENTING PROFESSIONAL ACTIVITY

Scientists are concerned about the conditions of research culture that has been distorted by the hyperbolization of requirements for the commercial utility of researches, economic efficiency of scientific results, and an attempt to assess all aspects of scientific activity using market-based

measures or just formal proxy metrics. These issues relate to science governance that requires special approaches. Whereas lack of consideration of characteristics of science as a system capable of self-organization and internal logic of development, leads to negative phenomena. B. A. Malitsky, while analyzing the situation in Ukraine, points out that the management of R&D institutions should be carried out "on the basis of a professional understanding of the nature of science, which, unfortunately, is absent within bureaucratic structures of ministries" [40, p. 24].

This situation doesn't contribute to the development of a creative research environment within science teams. Findings of sociological survey, conducted by independent global charitable foundation Wellcome Trust, presented a vivid picture of the problems in research culture. In 2019 the foundation conducted an online survey within 4,267 researchers (among them, 76% live in Britain, 24% in other countries; 84% work in R&D institutions and universities, 12% in industry, 2% in healthcare) [41]. Seventy-eight per cent of the respondents admitted that high level of competition in scientific environment has created unfavorable and stringed working conditions. Therefore, despite the fact that 84% of the respondents feel proud working in scientific community, only 29% feel confident to pursue career in science. The state of research culture is of the biggest concern: a creative atmosphere is one of the key features of research culture, 75% of the respondents admit the neglect of creativity as a feature of research activity that resulted in reduction of research quality. In general, only 33% of the respondents estimate research culture "positively", 12% "neutrally", and 55% "negatively" [41, p. 8]. Instead, the optimal research culture is an environment where there is support, cooperation, creativity, transparency and openness of management, individual contribution and diversity of knowledge and skills are appreciated, and time for contemplation is provided [41, p. 48].

Another problem is the situation of researchers who took up temporary, so-called post-doctoral positions, that is, positions without the prospects of further employment. This is important, because it primarily concerns scientific youth. In 2021 the Organization for Economic Cooperation and Development (OECD) presented a report on position of the research precariat, that is, researchers who took up temporary positions [42]. According to the surveys and interviews with politicians, managers and representatives of research organizations in OECD countries, the report provides disappointing estimates of the current situation: universities are turning into sweatshops that involve highly qualified specialists as poorly paid temporary workforce; ruthless labor exploitation takes place; temporary scientific staff shall postpone marriage and having children. The situation was further aggravated by the COVID-19 pandemic, as research spending decreased in certain fields, and recruitment for postdoc positions was reduced or delayed. All this has aggravated working conditions for researchers, especially young scientists. For changing the situation, it is necessary to improve the human resources management policy, to promote involvement and maintaining talented specialists in science sphere, expand inter-branch and international mobility, and form a transparent system of recruitment and performance assessment. These measures are aimed to maintain the diversity of research careers and create equal opportunities for everyone, taking into account the peculiarities of creative work. Such activities contribute to the development of science.

Ukraine also has these concerns. A particularly urgent is an employment issue, because the number of researchers in Ukraine has decreased sixfold over the past three decades. This runs counter to the global trends. According to UNESCO, in 2014—2018, the world number of researchers (full time equivalent) increased by 13.7%, i.e., its growth exceeded that of population, which made up 4.6% [32, p. 35]. According to estimates of O. S. Popovych and O. P. Kostrytsya, personnel potential of domestic science is currently in crisis: in recent years, youth recruitment has not even compensated for the loss of researchers due

to natural mortality. Furthermore, there is an intensive "washing out" of the middle-aged generation, which has resulted in critical changing of the age structure of researchers and makes it impossible to stop the further reduction of their number" [43, p. 77]. The situation remains difficult, because there is a decline in attractiveness of academic profession Ukraine, and it shall be addressed without delay. The sociological surveys have found that as compared with 2014, in 2017, the number of those, who negatively perceive the choice of close people to become a researcher, increased from 7% to 17%. The share of those, who have doubts about choosing scientific career by the closest people, increased as well (from 23%, in 2014, to 28%, in 2017) [44, p. 31].

SOCIAL ASPECTS OF THE PROJECT METHOD OF ORGANIZING SCHOLARLY RESEARCH

The above problems come from the forms of scientific activity that is increasingly organized in such a way as to comply with grant funding process, i.e. as short-term projects, for the sake of economic demand and efficiency. However, such processes cause professional problems for scientists. The peculiarity of research project is the combination of cognitive and practical goals in a single process: new knowledge production and turning this knowledge into useful products. Accordingly, the research project shall meet the needs and interests of various stakeholders: researchers, developers, business, customers, consumers, and also take into account possible risks, associated with practical implementation.

The literary sources emphasize both positive and negative aspects of the project as a form of organization of research activities. O.-H. Ylijoki believes that the biggest paradox of such an organization of research is that the format of project, being aimed at increasing efficiency, actually reduces it [45]. The problem is that the internal logic of research in the project, which is aimed at obtaining new knowledge, is opposed to external requirements (product development at the customer's request).

Many psychological problems also arise among project executors. The grant system implies dependence on research funding organizations and the instability of competitive process. This leads to uncertainty as to the professional future of researchers, causing anxiety and stress. This has a particularly negative effect on young researchers, who work under short-term contracts. Writing applications for the project competition is considered a wasted time, if they unable to withstand the competition. Tight deadlines for a project and control over all stages do not contribute to improving the quality of work, and, on the contrary, unlimited work time is considered a prerequisite for qualitative research.

According to M. Guggenheim, organizational structure of research project activities often requires interaction with customers, who are interested more in the obtained result than in the research process itself [46]. For the customer's convenience, research quality control involves bureaucratic methods rather than scientific disciplinary standards. The project organization enables researchers to perform new functions, namely to act as project manager. The requirements for the project manager have specific features, and include professional knowledge as well as personal traits, which are commonly called soft skills — flexible, soft, super-professional qualities, such as initiative, enthusiasm, confidence and ability to convince, ambition and strong will, tolerance, communication skills, developed imagination, an ability to reconcile technical solutions with time and human factors, high organization and discipline, the dominance of ability to generalize as opposed to specialization, propensity for planning and controlling, the ability to identify problems and willingness to make decisions. Therefore, project management has turned into one of the most demanded and promising management methodologies in the system of international and national professional organizations.

Implementation of interdisciplinary projects sometimes causes psychological problems, due to

the difficulties in formation of personal relationships and communication in interdisciplinary teams. Such problems are especially noticeable during necessity of common work between specialists in natural, social sciences and humanities. According to H. Ledford, representatives of the latter are reluctant to participate in such projects because they feel "pressure" from natural researchers, as well as sponsors and customers [47]. However, in general, interdisciplinary teams will be more effective than disciplinary one, particularly because development of an innovation often requires only familiar knowledge from another area.

Considering social problems of the project organization of research make it possible to draw following conclusions: research project enables raising the practical efficiency in science; it is an organizational tool that requires relevant knowledge and skills from executives and managers; it is initially aimed to solve a specific problem that cannot be solved within one discipline and requires interdisciplinary interaction and cooperation with a customer; has deadlines and certain stages that guide the research and may not be consistent with the logic of the cognitive process, which causes psychological discomfort for researchers; the customer's interests and requirements for results may not coincide with the corresponding ideas of direct executors, and requires coordination, numerous negotiations, and search for compromise. The specified features of the project organization of research make researchers and organizers of science to strive using opportunities and reducing negative effects.

SCIENCE COMMUNICATION WITH PUBLIC AND GOVERNMENT

In times of crises and social challenges the issues of scientific interaction with public and government are especially relevant. These periods are marked by the urgent issues of establishing communications between scientific experts and representatives of government and public.

The COVID-19 pandemic clearly demonstrated the problems of trust in science. In mass media, particularly online one, there was a lot of unverified and incorrect information that leads to rising anti-vaccination sentiments among the public. The situation with COVID-19 is not unique, similar processes have occurred before. D. G. Aksoy, B. Eichengreen, O. Saka [48] studied the impact of past epidemics on the trust in science and researchers, starting from the 1970s. They found that the experience dealing with an epidemic breeds distrust in expert conclusions of scientists, although people continue to value science as a source of knowledge about the world. According to R. Evans [49], the reason for mistrust of expert opinions is due to the fact that researchers have to work in the conditions of information uncertainty, a changing situation, shortage of time, and unclear tasks during emergencies. Therefore, sometimes they shall change conclusions, correct their own mistakes and this can be interpreted as a sign of biased attitude or corporate interests.

There are also difficulties in understanding the specifics of work in emergencies, while scientists giving consultative advice to politicians. R. Evans investigated the reasons for failure of the initial period of the struggle against the pandemic in Great Britain, which was officially recognized. The delay in lunching strict quarantine measures caused a high mortality rate. After analyzing the work of the UK government's Scientific Advisory Group for Emergencies (SAGE), R. Evans came to the conclusion that politicians wasted time, trying to wait for reliable information and irrefutable evidences from scientists. Therefore, it is necessary to understand what scholarly research can be conducted and what conclusions can be obtained in the allotted time, and "not letting the search for perfection to become the enemy of the good" [49, p. 74].

In addition, overcoming the emergencies usually considers the usage of interdisciplinary knowledge, including social and humanitarian disciplines. For example, during the COVID-19 pandemic issues of mental health, education, eco-

nomy, culture, etc. became urgent. In this regard, of a great interest is the experience of the Swiss National COVID-19 Scientific Task Force, where, as compared with similar advisory groups in other countries, there was represented a wide range of specialists: doctors, immunologists, virologists, epidemiologists, nursing specialists, as well as representatives of a wide range of science disciplines related to the support of policy decisions: economists, legal experts, sociologists, experts in ethics and pedagogical sciences, and also involve experts in political science and history if necessary [50].

Therefore, the problems in science communication with public and the government during the performance of research and expert-consultative functions in emergency situations often occur. To minimize them, it is necessary to develop a culture of science communication in society and scientific community, to enhance people's science literacy, particularly, among managers at various levels. The complexity of the problems also need to be considered, and engage into the work specialists in respective natural, medical, technical, mathematical, as well as social and humanitarian disciplines.

In this context, it will be useful to refer to the studies in history of science and technology, which was considered a worldview discipline by academician V. I. Vernadsky. L. M. Byesov emphasizes the methodological importance of history of science and technology for the development of human activity theory and practice. After all, history of science and technology examines regularities of the scientific knowledge evolution in their relation to the history of mankind, is critical regarding accumulated knowledge, reveals contradictions when explaining and assessing the stages of technology development, generates the need for new knowledge not only in chosen specialty, but also in related fields, contributes to the development of synergistic thinking and a holistic worldview [51, p. 3—7].

One of the important and positive consequences of introduction to the social history of science is the impact on shaping the complex of socially significant traits of a harmonious individual of society as a person with a developed consciousness, wide range of needs and sufficient capacities for their realization, which is the highest goal of the constitutional state and civil society. The role of the individual in society is especially important in times of crisis. There is an increasing interest in history, experience of previous generations, while a person is looking for the ways out. As L. D. Yakubova noted, "it is the discourses that transform human life into a reasonable and apparently meaningful (that is, not devoid of meaning) process that put the individual beyond the physiological existence as a time between birth and death... Temporal consciousness in one's ancestry ... is the fundamental basis of forming an individual as a social being, as basic as morality and law, an indication of a person/social community that has overcome the stage of savagery and barbarism. In wartime (it lasts more than eight years) national history becomes a weapon and a symbol of national sovereignty as well as the territory, the anthem, the flag, the coat of arms and the Constitution. To turn away from it is to lose a part of sovereignty and subjectivity. The more clearly we understand our past, the fewer mistakes we will make in the future, the less likely "stepping on the rake", the more human we are" [52].

The study, usage and popularization of the expertise of the socio-cultural context of scientific area, the analysis of achievement in fundamental researches and activities of leading Ukrainian and international research institutes and institutions, historical biography studies of researchers and organizers of research, and examples of their heroic activity sometimes in similar historical periods are important in formation of a strategy for the development of national R&D, socio-economic, socio-political and human potential, sustainable development, ensuring Ukraine's global competitiveness. These measures will contribute to the consolidation of society, since they are focusing on the need for comprehensive support of intellectual activity, which ensures continuing education, development and self-improvement for

individuals, and understanding the urgency of solving global civilizational problems; make the case for preserving and using traditions in research activity and promoting respect for it in society. A sense of real and deep patriotism is based on pride in the achievements of previous generations of native scientists. For example, an analysis of the history of space engineering and atomic science and technology of Ukraine is important for the creation of Ukrainian weapons, which will be useful in renewing the respective industries [53].

History of science and technology, as a historical discipline, follows the functions of general historical science: cognitive function that is to objectively, in view of historicism, assess phenomena and processes, which makes it possible to avoid mistakes of the past in the future; practical-political function that contributes to the development of correct policy on the basis of theoretical study of historical facts and patterns of social development; worldview (communication) function aimed at transmitting information across generations, which, together with language, religion, customs, contributes to preservation of one's own self-identification; educational function of explanation to society the historical phenomena and events that took place; pedagogical function, i.e. shaping, based on examples of past events, the qualities of a person and a citizen that can be beneficial for society and the country [54].

Social history of science is developed on the basis of social history, a branch of historical knowledge that studies the social life of different human communities in the world as a whole and its regions chronologically and within particular historical periods. It uses currently methods of both social history and sociology, and covers demographic, ethnic and gender history, family and childhood history, also of education, work, cities and towns, oral history, social aspects of political and military history. R. Merton and D. Bernal, the innovators in sociology of science, are also authors of social historical and scientific studies for a reason (the works of R. Merton "Science, Technology and Society in England in the 17th Century" (1938) and D. Bernal "The Social Function of Science" (1939), "Science in the history of society" (1954)). According to English sociologist of science R. Whitley, this turn was facilitated by the prerequisites — cognitive and social institutionalization. The former had developed scientific tools: research methods, research programs, object models, while the latter was related to collective work of scientists, regular contact and cooperation within the research environment, establishment of professional associations, organizations, societies, forums and journals, which enabled direct expansion of social resources [55].

Thus, the results of research on history and sociology of science have the heuristic potential to identify problems and perform mechanisms to enhance development of science and society, to solve both the problems of scientists' professional activity and interaction of science and society in times of crisis.

CONCLUSIONS

Under conditions of the impact of science on all spheres of social life, social processes cease to be external factors of scientific development, they are interwoven into all stages of research process: the problem statement, setting the tasks, and assessment of research results. This is particularly noticeable in times of crisis and transition in social development.

The requirements for commercial utility of research and economic efficiency of scientific results often lead to the problematization of research culture and negatively affect the attractiveness of scientific work, especially for young scientists.

To increase the social impact of science, researches are organized in such a way as to comply with requirements of grant funding process i.e. as short-term projects, which leads to new social problems that require comprehending and finding ways to address them. Both changes in the system of training research personnel, in establishing the activities of interdisciplinary collectives, and processes of harmonizing the logic

of the cognitive process and the requirements of practice are necessary. It is an urgent matter for employees of R&D institutions and universities to acquire competencies in the project management, to improve their knowledge on project preparation and management.

The need for expert advisory functions of scientists increases during periods of finding the best way outs of emergencies, but neglecting the essential features of science often leads to problems in science communication with society and the government. It implies the set of measures both to increase scientific literacy of society and managers at all levels, and to make appropriate changes in the training of researchers, including in their professional disciplinary competencies in social and humanitarian area of values.

Studying the history and sociology of science enables identifying the mechanisms of enhancing the development of science and society through mutual understanding, inclusive and sustainable growth.

The prospects for further research are as follows:

1. To implement successfully innovation model of the development of Ukraine's economy, to upgrade R&D production, increase competitiveness of domestic products on internal and external markets, it is necessary to pay significant attention to the development of society's innovation culture and implementation of a science-centric government policy, social and humanitarian sphere shall become one of the priority areas of innovation in Ukraine.

2. Particular attention should be given to the use of empirical methods of social research in science; scientists as well as journalists shall have free access to all possible objects of research.

3. It is necessary to organize monitoring of sociological data related to the communication of power structures with science and scientists with government structures. These data should be open, available to the general public, covered regularly in mass media.

4. Given significant cultural, popularizing, worldview, patriotic and image potential of history of science and technology, which, owing to the generalized experience of previous generations of scientists, contributes to enhancing the impact of science in social practice and overcoming the difficulties of crisis times, to implement master's and postgraduate programs in history of science and technology at Ukrainian universities.

5. Pay special attention to the development of the latest methods of science popularization that use the principle of engaging society to science, also "citizen science" projects. At the same time, it is important to promote achievements in natural, technical, as well as social and humanitarian sciences, their potential use in various practices, including social, economic, and political ones. To intensify discussions in society on topical issues of science development, problems of scientific ethics, assessment of the perception of science and technologies in general.

REFERENCES

1. Horobets, V. M. (2010). New social history. *Encyclopaedia of the history of Ukraine*. Vol. 7. Kyiv. URL: http://resource.history.org.ua/cgi-bin/eiu/history.exe?&I21DBN=EIU&P21DBN=EIU&S21STN=1&S21REF=10&S21FMT=eiu_all&C21COM=S&S21CNR=20&S21P01=0&S21P02=0&S21P03=TRN=&S21COLORTERMS=0&S21STR=Nova_sotsialna (Last accessed: 20.11.2022) [in Ukrainian].
2. Bogolyubov, O. M. (1994). Social history of mathematical natural science. *Essays on the history of natural science and technology,* 41, 3—16 [in Russian].
3. Ogurtsov, O. P. (2001). Social history of science: strategies, directions, problems. *Principles of historiography of natural science: XX century.* St. Petersburg. P. 34—68 [in Russian].
4. Potishchuk, O. O. (2012). Methodological strategies of social history of science. *Bulletin of NTUU "KPI". Philosophy. Psychology. Pedagogy,* 3(36), 49—55 [in Ukrainian].
5. Shashkova, L. O. (2006). Methodological aspects of problems of integration of natural-scientific-social-humanitarian knowledge. *Scientific Bulletin of Chernivtsi University: Philosophy*, 309—310, 9—13 [in Ukrainian].

6. Kuhn, T. S. (1974). Second Thoughts on Paradigms. In F. Suppe (Ed.). *The Structure of Scientific Theories*. Urbana. P. 459—482.
7. Knorr-Tsetina, K. (2006). Sociality and objects. Social relations in post-social knowledge societies. *Sociology of things*. Moscow [in Russian].
8. Braben, D. W. (2020). *Scientific Freedom: The Elixir of Civilization Hardcover*. San Francisco.
9. Forsberg, E., Geschwind, L., Levander, S., Wermke, W. (2022). *Peer review in an Era of Evaluation: Understanding the Practice of Gatekeeping in Academia*. Cham.
10. Bjørkdahl, K., Santiago, A., Duharte, F. (2022). *Academic Flying and the Means of Communication*. Palgrave Macmillan (Last accessed: 20.11.2022). https://doi.org/10.1007/978-981-16-4911-0.
11. Ryzhko, L., Onoprienko, V., Bessalova, T., Zhivaga, O. V., Borozdikh, N. V. (2019). *A scientist in postmodern culture*. Kyiv. URL: https://stepscenter.org.ua/wp-content/uploads/2022/06/monografia_block.pdf (Last accessed: 20.11.2022).
12. Macfarlane, B. J. (2019). The neoliberal academic: Illustrating shifting academic norms in an age of hyper-performativity. *Educational Philosophy and Theory,* 53, 5. https: //doi.org/10.1080/00131857.2019.1684262.
13. Onoprienko, V. (2015). *The image of science in changing society.* Saarbrücken [in Russian].
14. Petricini, A. T. (2022). *Friendship and Technology: A Philosophical Approach to Computer Mediated Communication*. New York. https://doi.org/10.4324/9781003188810.
15. Martinez-Vargas, C. (2022). *Democratizing Participatory Research. Pathways to Social Justice from the South*. Cambridge. https://doi.org/10.11647/OBP.0273
16. Hennessy, S. (2014). *Bridging between Research and Practice. Supporting Professional Development through Collaborative Studies of Classroom Teaching with Technology.* Rotterdam. URL: https://brill.com/view/title/36714 (Last accessed: 20.11.2022).
17. Bucchi, M., Trench, B. (Eds.). (2018). H*andbook of Public Communication of Science and Technology.* Moscow [in Russsian].
18. Maasen, S., Dickel, S., Schneider, C. (Eds.). (2020). TechnoScienceSociety. Technological Reconfigurations of Science and Society. *Sociology of the Sciences Yearbook, SOSC*, 30, 1—18. https://doi.org/10.1007/978-3-030-43965-1.
19. Rommetveit, K. (Ed.) (2022). Post-Truth Imaginations. New Starting Points for Critique of Politics and Technoscience. New York.
20. Dobrov, G. M. (1989). *Science of science*. Kyiv [in Russian].
21. Bogomolets, O. O. (1956, 1958). *Selected works*. V. 1—3. Kyiv [in Russian].
22. Born, M. (1977). *Reflections and memories of a physicist.* Moscow [in Russian].
23. Ostwald, V. (1910). *Greatest people*. Saint-Petersburg [in Russian].
24. Zerbino, D. D. (1994). *Scientific school as a phenomenon*. Kyiv [in Russian].
25. Kuhn, T. (1975). *The structure of scientific revolutions*. Moscow [in Russian].
26. Lakatos, I. (1978). The history of science and its rational constructions. In: *Structure and development of science*. Moscow, 204—269 [in Russian].
27. Mykulinsky, S. R., Yaroshevsky, M. G., Kreb, H., Steiner, G. (Eds.). (1977). *Schools in science: collection.* Moscow [in Russian].
28. Kartsev, V. P. (1984). *Social psychology of science and problems of historical and scientific research.* Moscow [in Russian].
29. Khramov, Yu. O. (1991). *History of establishment and development of physics schools in Ukraine*. Kyiv [in Russian].
30. Khramov, Yu. O. (1986). Scientific leader and his characteristic features. *Science of science and informatics*, 27, 81—91 [in Russian].
31. Malitsky, B. A. (2007). *Applied science of science*. Kyiv [in Ukrainian].
32. Schneegans, S., Lewis, J., Straza, T. (Eds.). (2021). *UNESCO Science Report: the Race Against Time for Smarter Development*. UNESCO Publishing. Paris.
33. Hessels, L. K., van Lente, H. (2008). Re-thinking new knowledge production: a literature review and a research agenda. *Research Policy*, 37, 740—760. URL: http://www.ask-force.org/web/Peer-Review/Hessels-Re-thinking-New-Knowledge-Production-2008.pdf (Last accessed: 20.11.2022).
34. Nowotny, H., Scott, P., Gibbons, M. (2001). *Re-Thinking Science: Knowledge and the Public in an Age of Uncertainty.* Cambridge.
35. Ziman, J. (2000). *Real Science: What It is, and What It Means.* Cambridge.
36. Macfarlane, B., Cheng, M. (2008). Communism, Universalism and Disinterestedness: Re-examining Contemporary Support among Academics for Merton's Scientific Norms. *Journal of Academic Ethics,* 6, 67—78. https://doi.org/10.1007/s10805-008-9055-y
37. United Nations. (2021). Technology and innovation report. Catching technological waves. Innovation with equity. URL: https://unctad.org/publication/technology-and-innovation-report-2021 (Last accessed: 20.11.2022).

38. European Commission (2022). Directorate-General for Research and Innovation, European Research Executive Agency, Publications Office of the European Union, *CORDIS results pack on science communication*, Publications Office of the European Union. https://data.europa.eu/doi/10.2830/389864
39. Hessels, K. L., van Lente, H., Smits, R. (2009). In search of relevance: the changing contract between science and society. *Science and Public Policy*, 36(5), 387—401. https://doi.org/10.3152/030234209X442034.
40. Malitsky, B. A. (2023). Science-centric state policy as a necessary and effective tool for improving living standards in Ukraine. *Science and science of science,* 1(119), 18—34 [in Ukrainian]. https://doi.org/10.15407/sofs2023.01.018.
41. What researchers think about the culture they work in. Wellcome, 15 January (2020). URL: https://wellcome.org/reports/what-researchers-think-about-research-culture (Last accessed: 09.02.2023).
42. OECD. (2021). Reducing the precarity of academic research careers. *OECD Science, Technology and Industry Policy Papers,* 113. Paris. https://doi.org/10.1787/0f8bd468-en.
43. Popovych, O. S., Kostrytsya, O. P. (2023). Towards the search for the optimal dynamics of building up the personnel potential of Ukrainian science in a period of its post-war recovery. *Science and science of science,* 1(119), 69—80. https://doi.org/10.15407/sofs2023.01.069 [in Ukrainian].
44. Petrushyna, T. (Ed.). (2017). *Domestic science in the sociological dimension*. Kyiv [in Ukrainian].
45. Ylijoki, O-H. (2016). Projectification and conflicting in academic knowledge production theory. In: *Theory of science,* 38(1), 7—26. https://doi.org/10.46938/tv.2016.331.
46. Guggenheim, M. (2006). Undisciplined research: the proceduralisation of quality control in transdisciplinary projects. *Science and Public Policy,* 33(6), 411—421.
47. Ledford, H. (2015). How to solve the world's biggest problems. *Nature,* 525, 308—311. https://doi.org/10.1038/525308a
48. Aksoy, C. G., Eichengreen, B., Saka, O. (2020). Revenge of the Experts: Will COVID-19 Renew or Diminish Public Trust in Science? *IZA — Institute of Labor Economics*, 13865. URL: https://www.econstor.eu/bitstream/10419/232617/1/dp13865.pdf (Last accessed: 30.01.2023).
49. Evans, R. (2022). SAGE advice and political decision-making: 'Following the science' in times of epistemic uncertainty. *Social Studies of Science,* 52(1), 53—78. https://doi.org/10.1177/03063127211062586
50. Final report of the Swiss National COVID-19 Science Task Force (NCS-TF). *Swiss National COVID-19 Science Task Force*. March, 2022. (2022). URL: https://sciencetaskforce.ch/wp-content/uploads/2022/06/AbschlussberichtSTF-29Mar2022-DE_en_final.pdf (Last accessed: 02.01.2023).
51. Byesov, L. M. (2004). *History of science and technology.* Kharkiv [in Ukrainian].
52. Petrenko-Tseunova, O. (2022). Why is history timely? Scientists explain. *Ukrainian Week* (July 19). URL: https://tyzhden.ua/chomu-istoriia-na-chasi-poiasniuiut-naukovtsi (Last accessed: 02.01.2023).
53. *History of the rocket and space science and engineering of Ukraine*. (2021). Kyiv [in Ukrainian].
54. Zhukovsky, A. I. (2011). History. In: *Encyclopedia of Modern Ukraine*. Kyiv. URL: https://esu.com.ua/article-12823 (Last accessed: 15.04.2023).
55. Whitley, R. (1980). Cognitive and social institutionalization of scientific specialties and areas of research. In: *Scientific activity: structure and institutions*. Moscow, 218—257 [in Russian].

Received 25.04.2023
Revised 13.10.2023
Accepted 19.10.2023

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ІСТОРІЯ ТА СОЦІОЛОГІЯ НАУКИ У КРИЗОВІ ТА ПЕРЕХІДНІ ПЕРІОДИ СУСПІЛЬНОГО РОЗВИТКУ

Вступ. У переломні чи кризові періоди соціального розвитку актуалізується необхідність пошуків форм взаємодії науки та суспільства, нагальною стає потреба розв'язувати проблеми організації наукової діяльності й індивідуальної праці вченого, виявляти наукові проблеми, розв'язання яких сприяє подоланню суспільних викликів. Для вирішення цих завдань доцільно використати евристичні можливості досліджень з історії та соціології науки й набутий ними досвід.

Проблематика. Переосмислення предметних сфер і завдань історії та соціології науки, які пропонується розглядати не тільки як історичний опис впливу соціальних процесів на розвиток науки, або науки на суспільство, а як знання, що дозволять виявити механізми активізації розвитку науки та суспільства на засадах взаєморозуміння, інклюзивного і стійкого росту, інноваційної культури.

Мета. Виявити евристичні можливості історії і соціології науки для формування шляхів подолання викликів взаємодії науки та суспільства у ситуації кризових станів, пов'язаних з практичною орієнтацією сучасної наукової сфери, нагальними проблемами професійної діяльності вченого, соціальними аспектами проєктного способу організації наукових досліджень, питаннями комунікації науки з суспільством і владою в часи пандемії та війни.

Матеріали та методи. Комплексне використання загальнонаукових принципів історизму, об'єктивності, достовірності, цілісності, системності та репрезентативності.

Результати. Обґрунтовано, що дослідження з історії та соціології науки дозволяють виявляти проблеми і механізми активізації розвитку науки та суспільства на засадах взаєморозуміння, інклюзивного і стійкого росту.

Висновки. Для успішного впровадження інноваційної моделі розвитку економіки України необхідно приділяти значну увагу розвитку інноваційної культури суспільства та впровадженню наукоцентричної державної політики, для цього соціально-гуманітарна сфера має стати одним із пріоритетних напрямів інноваційної діяльності в Україні.

Ключові слова: історія науки, соціологія науки, кризові періоди суспільного розвитку, дослідницький проєкт, дослідницька культура, комунікація науки з суспільством та владою, інноваційна культура суспільства.