DOI: 10.15825/1995-1191-2019-4-147-154

SERGEI BRUKHONENKO – THE FOUNDER OF CARDIOPULMONARY BYPASS (PHILOSOPHICAL, METHODOLOGICAL AND SOCIOCULTURAL CONTEXT)

A.Y. Ivanyushkin[1, 2], *O.N. Reznik*[3, 4, 5], *O.V. Popova*[5]

[1] Moscow Pedagogical State University, Moscow, Russian Federation
[2] Serbsky Federal Medical Research Centre of Psychiatry and Narcology, Moscow, Russian Federation
[3] Dzhanelidze Research Institute of Emergency Medicine, St. Petersburg, Russian Federation
[4] Shumakov National Medical Research Center of Transplantology and Artificial Organs, Moscow, Russian Federation
[5] Institute of Philosophy, Russian Academy of Sciences, Moscow, Russian Federation

This paper is dedicated to Sergei Brukhonenko (1890–1960), a physiologist and inventor of the world's first heart-lung machine. His immense contributions to the development of modern science and technology are investigated. Brukhonenko's invention is seen as modern biotechnology that has attracted an all-round strong public interest. A philosophical analysis of the differences between the concepts "*technique*" and "*technology*" is presented. The paper discusses the sociocultural impact of biotechnology on the society and culture.

Keywords: Sergei Brukhonenko, cardiopulmonary bypass, technology, scientific priority, truant doctor.

1. INTRODUCTION

The invention of the cardiopulmonary bypass (CB) technology is one of the most outstanding high-tech achievements of the 20th century biomedicine. The word "high-tech" here requires clarification. For example, such a scientific discovery as anesthesia and its introduction into surgical practice of (mid-19th century) did not require preclinical studies at all. In contrast to anesthesia, the CB method (in the 1950s) was introduced into clinical practice after decades of development of physiological knowledge and, simultaneously, improvement of methods for open perfusion of isolated organs (e.g. heart). Only then could the problem of perfusion of the whole organism be solved. That is, the "small" and "large" circles of blood circulation known to science since the time of M. Servetus and W. Harvey had to be reproduced in the form of a single technological circuit if the "artificial heart plus artificial lungs".

The priority for creating the first CB automatic device belongs to the Russian doctor, physiologist, inventor S.S. Bryukhonenko (1890–1960) [1, 2, 3, etc.]. S.S. Bryukhonenko called his CB device the "auto-jector". Generally speaking, the historical fate of the terms that the authors themselves used to designate their great scientific discoveries and technical inventions is always fascinating when viewed in the context of the history of science. For instance, Isaac Newton called his law of universal gravitation the "law of inverse proportionality", and V.K. Zvorykin named his television set an "iconoscope". The name S.S. Bryukhonenko gave to his CB device holds a worthy place in this set of the most important discoveries and inventions in science and technology. Already in the first decade the CB method was used in clinics (late 1950s – early 1960s), several technical modifications of the "auto-jector" existed in Russia, and in other countries, over 70 [4].

We use the term "technology" to reveal a deeper, more general cultural meaning of the contribution to science S.S. Bryukhonenko made, focusing on philosophical issues, sometimes just slightly mirrored in his works. The concept of technology is used in modern philosophy of science and technology both in narrow and broad senses [5]. In a narrow sense, this is clear to every literate person of today (e.g. the technology of metallurgical production known since the time of the first civilizations). The concept of technology in the broad sense is most often associated with such achievements of modern civilization as information technology or biotechnology. In this sense, the concept of technology implies, first of all, an innovative component, that is, a permanent solution in line with this scientific and technical progress solving more and more scientific tasks, the implementation of novel technical projects; secondly, a fundamentally new model of the relationship between science (new forms of organization of scientific research in particular) and social practices; thirdly, the "embeddedness" in the accelerating processes of scientific and technological development proper of the value component (moral, philosophical, religious, etc. reflection) [6].

Corresponding author: Ivanyushkin Alexander Yakovlevich. Address: 23, Kropotkinsky per., Moscow, 119034, Russian Federation. E-mail: a_ivanyushkin@mail.ru

CB as a method of experimental and clinical surgery is also a technology, if only because the creation of this method made possible the accelerated development of resuscitation and transplantation with philosophical problems "embedded" in these clinical practices.

S.S. Bryukhonenko's pioneering in creating the CB technique has been noted in reports at scientific congresses, publications in scientific journals, Soviet and foreign, from the mid 1920-s. Many Soviet authors have emphasized the significance of the patents S.S. Bryukhonenko got on his CB device: in Germany and the UK (1929), in France (1930) and the USSR (1934). Despite that, it was sorry to hear the words of the clinical heart transplant pioneer K. Barnard during his visit to Moscow leading surgical clinics in 1960[1], he did not see any open heart surgery and was "so disappointed with the state of surgery in the USSR that he would not recommend it to anyone as the place for training and experience in this area" [7].

Nevertheless, if truth be told, it should be mentioned that the first operation in the USSR with the use of the Soviet-made CB device was made by A.A. Vishnevsky November 27, 1957 [2]. In general, the fact of a certain lag in the application of the technique in the Soviet medical practice is undeniable. However, let us note another point: the first stage of introducing the CB technique into clinical practice can be called a "dramatic medicine" (G. Glazer). Here we find a concretization of the problem of the demarcation of two concepts, engineering and technology. The ethical dilemmas that the hero of the novel by N.M. Amosov (1913–2002) "Thoughts and Heart" is only the beginning. Very soon, with the development of clinical transplant, the further progress of surgery in this area will depend on the legitimation of a new criterion for death (brain death), on the creation of a new ethical and legal basis for justification, reasoning and regulation of organ donation practices.

2. S.S. BRYUKHONENKO'S AUTO-JECTOR: "LIVING HEAD" SENSATION EXPERIMENT[2]

The years S.S. Bryukhonenko formed himself as a creative person, coincided with the Russian Revolution and the following turbulent decades of the Soviet history. His father was a railway engineer, and from his youth he showed a fondness of invention. Entering the gymnasium in Saratov, he finished his education in Moscow. In the 1910–1914, as a student at the medical faculty of the Imperial Moscow University, he was fascinated by bacteriology. In 1914, having graduated from the university and signed the "Faculty promise" (a kind of Hippocratic oath, a set of ethical and professional rules for a doctor in pre-revolutionary Russia), he went to the WWI front as a regimental doctor. Having returned home from the front, already to the Soviet Russia, he again found himself "at the front" of the fight against typhus and cholera.

At that time, Sergey Bryukhonenko met Professor F.A. Andreev, the author of 1913 work "On Experience in Restoring the Activity of the Heart, Respiration and Functions of the Central Nervous System". F. Andreev was a prominent Russian clinician and an outstanding scientist whose innovative systematic ideas largely predetermined the development of such high-tech areas of biomedicine of the 20th century as resuscitation and transfusiology. P.M. Bogopolsky et al. note: "Since 1907, F.A. Andreev has researched into various issues, among which… the concept of "imaginary" death in the period of living existence of isolated organs and the whole organism; the restoration of heart function in conditions of adequate coronary perfusion; injection of Ringer-Locke solution with adrenaline or defibrinated blood into the carotid artery … simultaneously with intra-arterial infusion, suction of blood from the superior vena cava … use of hirudin and peptone to reduce blood coagulation … study the possibility of restoring the central nervous system and the whole body with CB" [3]. S.S. Bryukhonenko worked as an assistant to Professor Andreev from 1919 to 1924.

A young doctor started the creation of CB technique with the *methods for an experimental study of the fundamental problems of pathophysiology*, looking for new therapeutic agents for the treatment of typhus. A kind of a "natural experiment" was the cholera locus broke out among typhoid patients. Bryukhonenko drew attention to the fact that bacteriologically proven cholera which began on the 6th–7th day of the disease with typhus seemed to cut it off. It also turned out that cholera was accompanied by a decrease in blood coagulability, while typhus was associated with its increase [2]. Having discovered this clinical phenomenon, Bryukhonenko began to inject anticoagulants and some other pharmacological substances into the veins of such patients. As a result, in 95% of cases an artificially caused crisis arose, and in 5% of cases it was possible to interrupt the disease course. F. Andreev suggested that his assistant find an explanation for the revealed phenomenon, exploring separately the role of the nervous and humoral factors of the thermoregulation mechanism. Bryukhonenko set an ambitious goal of studying the mechanics of thermore-

[1] Barnard visited the USSR during the 27th All-Union Congress of Surgeons (May 23 to May 28, 1960).

[2] In this brief sketch of S.S. Bryukhonenko's life, we used not only published works [2, etc.], but also personal memoirs of professor-biologist L.F. Kurilo, who worked in 1957–1958 a laboratory assistant in the Physiological Laboratory at the Scientific Research Institute of Experimental Surgical Instruments and Instruments (NIIEHAiI) of the Ministry of Health of the USSR led by S.S. Bryukhonenko. For this we are sincerely grateful.

gulation on the biological model of the *"isolated head" of a hemathermal animal*.

S.S. Bryukhonenko recalled: "Between 1920 and 1923. *I invented and constructed an apparatus for cardiopulmonary bypass*, an auto-jector, and developed the method of isolating a dog's head …" (italics added – A.Ya., O.N., O.V.) [2]. Some publications express an opinion that the first CPB pump was created by S.S. Bryukhonenko in collaboration with S.I. Chechulin. In this regard, A.G. Lapchinsky (who was at that time S. S. Bryukhonenko's employee) in his report to the Moscow Society of Surgeons in 1961 (in connection with the anniversary of the death of S.S. Bryukhonenko) remarked a "mistake that somehow crept in" [1]. S.P. Glossy emphasizes that S.I. Chechulin took part in the improvement of the "auto-jector", though this improvement concerned only minor details [8].

The attempts to ensure the vital activity of the "isolated head" of a hemathermal animal (using perfusion of blood vessels) have been repeatedly undertaken by scientists before, A.A. Kulyabko, in particular; however, all of them were unsuccessful. Why? Here it is appropriate to cite I.P. Pavlov in that "science moves in jumps, depending on the successes made by the technique" [9]. No one was able to achieve the result of "keeping alive" such an organ as the head of a hemathermal animal, as no one had created a scientific task adequate for the scientific method.

S.S. Bryukhonenko and S.I. Chechulin carried out together the physiological experiments with a biological model of the "isolated head". In their work published in 1928, "Experiments on Isolating a Dog's Head (with a Demonstration of the Instrument)" [10] they published the "Background". In the beginning of the review, the idea expressed by J.J. S. Le Gallois is cited: through the transfusion of blood, to revitalize the brain (after decapitation). In general, the review provided an analysis of more than a dozen works from 1834 to 1924 by French and English authors[3] (including Charles Edouard Brown-Séquard). The authors emphasize: "One cannot fail to see attempts to create conditions for truly artificial blood circulation". However, the analysis of the difficulties in solving many physiological and technical issues drew them to conclusion that "none of the researchers could do this in full" [10]. A reason was that for most physiologists, the method of separating the head from the trunk of experimental animals seemed "barbaric"[4]: "The decapitation of the animal was carried out primitively, with the help of a specially arranged guillotine … Therefore, we chose a *purely surgical path*, and the head was removed gradually and in a certain sequence" (italics added – A.Ya., O.N., O.V.) [10].

Let us dwell on the latter words of Russian scientists, recalling that the very creation by Andreas Vesalius of the modern scientific anatomy is genetically related to the new cultural meaning of the relationship to the human body. The rigorous scientific observation, the scientific objectivity of the research activities of the anatomists here turned into a more careful, more respectful, more humane attitude to human organs and tissues.

The scale and prominence of the scientific and technical invention made by S.S. Bryukhonenko goes beyond the frame of the technical progress as such. Proving the effectiveness of the auto-jector, a new discipline of clinical and experimental surgery has emerged, i.e. perfusion. An optimistic thought was expressed in one of the recent reviews of the history and achievements of perfusion (2015) on the theoretically possible *ideal perfusion* of the future (italics added – A.Ya., O.N., O.V.) [11]. But in fact, while we are dealing with the symbiosis of a machine and a person, it's just a prosthetics of such an attribute of life as blood circulation. And then the techno-pessimistic question arises, "Is it possible to create a "perfect graft" of blood circulation in general?" CB *as a technology* most eloquently illustrates the trend of a modern individuum to transform "at the level" of being, existence itself, as a result of which a person in the modern world acquires the quality of an "artifact" [12].

Since 1925, S.S. Bryukhonenko and S.I. Chechulin have repeatedly demonstrated to the public their experiment of "revitalizing the dog's head" at the All-Russian congresses of pathologists and physiologists (and at the 4th congress in 1930, in the presence of invited foreign scientists). The demonstrations continued at the 6th Congress (after the death of S.I. Chechulin in 1938). The fact should be emphasized that representatives of the highest authorities of the Soviet state were usually present at such demonstrations. After a successful show at Moscow State University in 1928, to expand the research of S.S. Brukhonenko, a sim of 30 thousand rubles was allocated and an experimental therapy laboratory was organized. Finally, after a series of scientific forums where the demonstration of "revitalizing the dog's head" was repeated over and over again, the 15th International Congress of Physiologists held in 1935 in Moscow under the chairmanship of Academician I.P. Pavlov, was a climax (the congress was generously funded by the state as it was given great political importance).

After the triumphal demonstration of the "revitalizing the dog's head" experiment at the 15th International Congress of Physiologists, the Scientific Council of People's

[3] S.S. Brukhonenko was fluent in English, German and French; in the last years of his life he studied Spanish [2].

[4] Historians of science emphasize that Brown-Séquard in his experiments separated the dog's head from the body with a saber strike [2].

Commissars of the USSR opened the Scientific Research Institute of Experimental Physiology and Therapy (NIIEFT) with S.S. Bryukhonenko as its director. At the same time, he was awarded the degree of Doctor of Medical Sciences (without defending a thesis). The staff of the new institute reached 150. The team developed and manufactured auto-jectors, which *aroused lively interest* after demonstrating experiments at scientific congresses and congresses" (italics added – A.Ya., O.N., O.V.) [2].

As one can see, the experimental physiological and clinical CB method S.S. Bryukhonenko created had, as an indirect consequence, the *widest public response*. A.A. Kulyabko, in an article published in 1928 in Pravda newspaper, stressed that S.S. Bryukhonenko's invention "made an enchanting impression". Of particular note is the international public interest: for example, Bernard Shaw in his usual ironic tone said he was ready to give Dr. Bryukhonenko his head for his experiments [2]. In 30 years, an experiment was made in 1953 by V.P. Demikhov (and his younger colleague and ally V.M. Goryainov) on a puppy dog head and front paws transplant onto the neck of an adult dog. Another decade passed, and the first clinical heart transplant by K. Barnard at the end of 1967 caused a public outcry, which was comparable in strength to the society reaction to the launch of the Soviet Sputnik in 1957 and the first manned flight into space in 1961.

All the above examples are cases of the *development of modern technologies*. As mentioned earlier, the concept of technology in the broad sense, bears something of a "virus"[5] of progressive innovations. In the mass consciousness of society, certain high expectations are associated with such technologies. Modern technology is such a striking *present* in our imagination of human life that is always promising an even *more amazing future*. A person's perception of modern technology can be described with "charm". Thus, modern technologies, being initially the stage of scientific and technological progress, include two other components, social (global "public response") and psychological ("charming and enchanting effect").

As mentioned earlier, the concept of technology in the broad sense implies an analysis of the *ideological, philosophical issues* that are "embedded" in them. S.S. Bryukhonenko and S.I. Chechulin's physiological experiments confirm this methodological position. They wrote in 1928, "The phenomena accompanying agony and death deserve special attention, that is why we are going to dwell on them … more in detail" [10]. On the following pages of their work, we find anticipation of the key problems of resuscitation (which emerged as an independent scientific discipline in the second half of the 20th century) problems equally belonging to both scientific and philosophical sphere. First of all, Bryukhonenko and Chechulin clearly formulate the basic category of resuscitation and intensive care as a "clinical death", but also use other terms, "temporary loss of function and reactivity", "apparent death", "imaginary death", "delayed death", as opposed to "final", real, actual death "[10].

The concepts of clinical and biological death were later introduced by V.A. Negovsky whose work gained fame abroad, which proves the priority of the Soviet science in the area. However, the mismatch of terms denoting the subject hides philosophical and methodological issues that require special analysis. Note that the term "clinical death" is *Scheintod* in German, that is, "apparent death". And the Russian literature expressed the point regarding the appropriateness of abandoning the terms "clinical" and "biological" death as contradicting the laws of logic [13].

Having justified the possibility of restoration of signs of life in an "isolated head" in his experiments with the help of an auto-jector (after 8 to 20-minute death), S.S. Bryukhonenko and S.I. Chechulin formulated the main question, "Is it possible to identify the phenomena of life and death that we observed on an isolated head with what we see on the whole organism?" [10] and further, "No one will doubt that we have a number of functions in which the nerve endings, conductors, sections of the central nervous system, some sensory organs and muscle groups take part. But is it possible to go further and call it all by that tempting term, namely, life? …We suppose this question is easier to solve than the question, What is life? Indeed, physiology has not yet been able to give a clear and precise definition of what can be called alive and what is dead"[6].

The above citations anticipate philosophical and methodological issues related to the legitimation by the modern society of a new criterion for the death of a person as "brain death". Let us look at the definition in the current legal act of the Ministry of Health of the Russian Federation: "The death of a human brain occurs with the complete and *irreversible termination* of all functions of the brain … The moment of death of the human brain is the *moment of human death*"[7] (italics added – A.Ya., O.N., O.V.).

Many philosophical debates surrounding the problem of brain death are focused precisely on the point

[5] It is no accident that in modern information technologies the concept of a "virus" has become their inherent characteristic.

[6] Spacing by Brukhonenko and Chechulin.

[7] The procedure for establishing the diagnosis of human brain death: Appendix No. 1 to the order of the Ministry of Health of the Russian Federation of 12.25.2014, No. 908n.

of straight identification of the both parts of the given definition. Here, S.S. Bryukhonenko and S.I. Chechulin in 1928 perceptively saw a certain "gap" (in both ontological and epistemological meanings) between the physiological facts of the *manifestation of life* in an "isolated head" and *life as such*. Here they were closer to their senior contemporary V.I. Vernadsky's opinion who wrote that the question of the essence of life is still being solved mainly at the level of religion or philosophy, that "science should approach this problem itself. Now, it's not the case". [14]. Therefore, following strict scientific criteria, he preferred to use the words "living substance" instead of "life". Obviously, in the philosophical dimension, the categories of life and death lie "on the same scale". It is well known that the legitimation of the new criterion of death ("brain death") is inextricably linked with the prospects for the development of transplant practice. This was most consistently reflected in the Japan Transplantation Law of 1997, "A patient who is diagnosed with brain death is legally dead *only if* being alive he approved the previous transplantation statement of brain death" (italics added – A.Ya., O.N., O.V.) [15].

Here is another philosophical reflection of Brukhonenko and Chechulin, "It is possible to imagine a state where excitability and functions are not detected but can be detected if there are suitable conditions" [10]. Here, they seemed to foresee the current philosophical doubts of some authors on whether the patient with the diagnosis of "brain death" is really dead.

3. S.S. BRYUKHONENKO, A DISCOVERER OF NATURAL GIFTS

Early 1920s in Russia were marked by radical breakdown of all social institutions, including science as one. S.S. Bryukhonenko recalled the details of the birth of his auto-jector, "The initial stage of the work was inventive in nature … one of the models … was a chaotic pile of metal and glass parts mounted on one tripod. Screws were cut from ordinary nails with coins soldered on them. How the details used medical syringes, electric bells, chemical glassware, etc." [2]. S.S. Bryukhonenko, having no special engineering education, was a mathematician, engineer, and designer; he, for example, in drawings of individual parts of the auto-projector, *minimized (to a square centimeter) the area of contact between the dead flesh of the machine and blood*.

As is known, for the first time in clinical practice, the CB apparatus was successfully used in 1953 in the USA by J.H. Gibbon (1903–1973). An essential detail is that in the history of the invention of the first American CB devices, an active role was played by IBM, the company which in the second half of the 20th century became a leader in computer manufacturing. However, the priority of S.S. Bryukhonenko in the development of clinical cardiac surgery cannot be denied. *In the article "Artificial blood circulation of a whole organism (dog) with a heart turned off" published in the USSR in 1928 and in France in 1929 (written in late 1926 – early 1927)*, Bryukhonenko proposed the possibility of operations on a stopped heart. In ten years, he conducts a decisive experiment (*experimentum crucis*): "I now recall this first and decisive experiment. In a dog under anesthesia, the chest cavity was opened, the cardiopulmonary bypass was connected to the body and turned on. I check the impeccability of his work and stop the work of the heart of the dog by simply pressing it with his hand. Usually in such cases agony and death quickly ensue. With natural excitement, I watch if these formidable symptoms appear. Not. A minute passes, then tens of minutes. The dog remains alive. On the same day, I phoned my colleague in previous work, surgeon Professor N.N. Terebinsky. After telling him about this experiment, I asked if he would be interested in the prospects that open up before surgeons due to the possibility of using this discovery for intracardiac operations with temporary heart switch-off" [2, p. 62][8].

Reading one of his most important works, "An apparatus for cardiopulmonary bypass (of the hemathermal)" published in 1928, any doctor understands that one of the main tasks that the author solved when modeling circular arterial and venous blood flow was to ensure automatic regulation within physiological norms of the pressure level in the bloodstream. However, the solutions to dozens of specific technical problems (for instance, avoiding danger of "causing contact soldering or oxidation" [16]) simply cannot be comprehended by the vast majority of specialists in the field of biomedicine. We would give an analogy: only professional musicians are able to appreciate many chapters of the book "Bach" by the world-famous philosopher, musician and doctor Albert Schweitzer (e.g. "The musical language of cantatas"). We believe that, having put the names of Schweitzer and Bryukhonenko in one row, we are dealing with the phenomenon of a creative personality of a renaissance scale, in both cases.

A remarkable confirmation of what has been said can be found in yet another fact of S.S. Bryukhonenko life. A few decades before the appearance of a personal computer, the scientist anticipated 3D computer graphics. He invented a device for stereoscopic three-dimensional objects imaging. He gave a scientific and physiological explanation to his invention: binocular vision peculiar to humans (when each eye sees an object, speaking the language of geometry, from a different angle) just provides

[8] On the contribution to the development of cardiac surgery N.N. Terebinsky see Klinicheskaya i eksperimental'naya khirurgiya. Zhurnal imeni akademika B.V. Petrovskogo. 2015. No. 3.

us with a three-dimensional perception of the world of material things. S.S. Bryukhonenko wrote: "If humanity still had a plane for its drawings, now we are giving it the opportunity to draw in three dimensions. I have been painting stereoscopically for five years and I believe that spatial images, which I could not always reproduce before, can now be drawn within five minutes. The result was learning spatial thinking" [2]. His invention was, in fact, the forerunner of modern 3D computer models used by modern medical students: "medical students could study with the anatomical atlas of stereo images, engineers could depict future devices in the form that the finished device should have, instead of complex layouts, architects could make simple drawings, etc." [2, p. 73].

4. S.S. BRYUKHONENKO AS A TRUANT PHYSICIAN

The words *truant physician* was first used by the famous English surgeon Lord Berkeley Moyniham (1865–1936). The well-known Russian professor in resuscitation science A.P. Zilber drew our attention to this fact. Zilber, who has been studying this cultural phenomenon for many years gives it the following definition, "Medical truentism is the fruitful desire of doctors to use creative work outside medicine" [13]. Many pages of his monograph "Ethics and Law in Critical Medicine" are devoted to such truants as N. Copernicus, N.I. Pirogov, A.A. Bogdanov and others. A. Schweitzer of course, also belongs to the most outstanding truants [17].

Let us dwell on the constant passion S.S. Bryukhonenko felt to creativity in the humanitarian sphere. Sergei Sergeyevich had an absolute ear for music. As a student, he worked part time as a tapeur in silent cinemas. Later, as his friend, the famous pianist Heinrich Neygauz recalled, Sergey Sergeyevich masterfully performed "God Save the Tsar" on the piano with one hand and the "International" with the other [19]. Under the influence of Bryukhonenko's experiments with a "living head", two science fiction novels were written, the well-known "Head of Professor Douel" by A. Belyaev and "Generator of Miracles" by Yu. Dolgushin. The prototype of the protagonist of the latter is S.S. Bryukhonenko. Yu. Dolgushin recalled, "My acquaintance with the famous physiologist and inventor, Professor Sergey Sergeyevich Bryukhonenko, had a huge impact on my work. When I first came to him, he revived dead dogs. Then I saw an "artificial heart" created by him, an apparatus that miraculously replaced a real heart for an animal while it returned to life. It was a preparation for experiments on humans. And it was already real science fiction… And *then Sergey Sergeyevich edited part of the chapters of the "Generator of Miracles"* (italics added – A.Ya., O.N., O.V.) [2]. The very title of the work of Dolgushin confirms our earlier distinction between the concepts of "technology" and "engineering" (the latter, as it were, charged with a "charming virus"). We cannot to avoid mentioning that S.S. Bryukhonenko knew M.A. Bulgakov[9] evidenced in the Diary (1933) of the writer's wife Elena Sergeevna, "We went to Yakimanka to the Institute of Blood Transfusion[10]. Bryukhonenko (Sergey Sergeevich) was very sorry that he could not show the revival of the cut off head of the dog – there is no suitable specimen. He showed some of his achievements. But most importantly, M.A. persistently suggested *to write a play – along with him* – based on some of his scientific experiments" (italics added – A.Ya., O.N., O.V.) [18].

S.S. Bryukhonenko biographers write in their "Afterword" in the book about him, "In the 1920s, he flew on an airplane of one of the first designs, with his legs still hanging in the air, and later he went down under the water in a diver's suit. He was an excellent swimmer and sought to develop new swimming techniques. Having learned to skate, he immediately went on to figure skating … On the eve of one of the most complex, fourth operations, he enthusiastically talked about the solution to a difficult mathematical problem he found … Sergey Sergeyevich was always far from fighting for titles and positions … He generously scattered ideas and did not regret it, because he had never run dry" [2].

5. CONCLUSION

Unfortunately, the priority of the successful application of CB technology in clinical surgery does not belong to Russia, but to Western countries. The main reason was that, in methodological terms, the CB technique (like all modern technologies) has a fundamentally interdisciplinary nature, and the general level of technological progress in the West at that time (1920–50s) was higher. P.M. Bogopolsky et al. critically evaluate the stage of creative searches S.S. Bryukhonenko in the 1930s–40s, when he predominantly dealt with the problem of "reviving the dead", stubbornly believing that the period of clinical death of approximately five minutes using the CB method could, in principle, be extended. It must be recognized that in the light of all subsequent experimental and clinical experience on resuscitation, the position of these authors is scientifically sound. For our part, we would add the following. Scientific worldview of S.S. Bryukhonenko was formed in the first decades of the 20th century, when scientific megaprojects, for

[9] This fact was brought to our attention by I.A. Ivanyushkin, Cand. Philos.

[10] In 1931–1935, Brukhonenko was the head of the experimental therapy laboratory at the Central Institute of Hematology and Blood Transfusion.

example, eugenics, were popular (in Russia, the works of N.K. Koltsov, Yu.A. Filipchenko and others are devoted to it). The idea that predominated, since 1920s, in the scientific work of S.S. Bryukhonenko, of "revitalization after death" was consonant with the very "spirit of revolution" in the then Russian society.

Prepared with the support of the Russian Science Foundation, grant No. 17-18-01444, 2019.

The authors declare no conflict of interest.

REFERENCES

1. *Lapchinskij AG*. S.S. Bryuhonenko – osnovopolozhnik iskusstvennogo krovoobrashcheniya. *Bryuhonenko S.S. Iskusstvennoe krovoobrashchenie: Sbornik rabot po voprosam iskusstvennogo krovoobrashcheniya*. M.: Nauka, 1964: 6–12.
2. *Sirotkina G, Gutkin VS*. S.S. Bryuhonenko. M.: Medicina, 1972.
3. *Bogopol'skij PM, Glyancev SP, Loginov DT*. Sergej Sergeevich Bryuhonenko – sozdatel' metoda iskusstvennogo krovoobrashcheniya (k 125-letiyu so dnya rozhdeniya). *Kardiologiya i serdechno-sosudistaya hirurgiya*. 2016; 6: 74–82.
4. *Andreev SA*. Proshloe, nastoyashchee i budushchee iskusstvennogo krovoobrashcheniya. *Sovremennye voprosy iskusstvennogo krovoobrashcheniya v ehksperimente i klinike* / Pod red. S.A. Andreeva. M.: Medicina, 1966: 9–25.
5. *Rozin VM*. Tekhnologiya. *Novaya filosofskaya ehnciklopediya*. V chetyrekh tomah. T. IV. M.: Mysl', 2001: 65.
6. *Tishchenko PD*. Biovlast' v ehpohu biotekhnologij. M.: IF RAN, 2001. 177.
7. *Anichkov NM*. 12 ocherkov po istorii mediciny i patologii. M.: Sintez buk, 2014: 167–188.
8. *Glyancev SP*. Fenomen Demihova. *Transplantologiya*. 2012; 1-2: 74–83.
9. *Pavlov IP*. Lekcii o rabote glavnyh pishchevaritel'nyh zhelez / Red. i stat'ya akad. K.M. Bykova. L.: Izd-vo akademii nauk SSSR, 1949.
10. *Bryuhonenko SS, Chechulin SI*. Opyty po izolirovaniyu golovy sobaki (s demonstraciej pribora). *Trudy Nauchnogo himiko-farmacevticheskogo instituta. Vyp. 20*. M.: Izd. Nauchno-tekhnicheskogo upravleniya V.S.N.H., 1928: 6–43.
11. *Averina TB*. Iskusstvennoe krovoobrashchenie. *Annaly hirurgii*. 2013; 2: 5–12.
12. *Popova OV*. Chelovek kak artefakt biotekhnologij. M.: Kanon+, 2017.
13. *Zil'ber AP*. Ehtika i zakon v medicine kriticheskih sostoyanij. Petrozavodsk: Izdatel'stvo Petrozavodskogo universiteta, 1998.
14. *Vernadskij VI*. Razmyshleniya naturalista, kn. II. Nauchnaya mysl' kak planetnoe yavlenie. M.: Nauka, 1977.
15. *Ivanyushkin AYa, Popova OV*. Problema smerti mozga v diskurse bioehtiki. M.: Nota bene, 2013.
16. *Bryuhonenko SS*. Apparat dlya iskusstvennogo krovoobrashcheniya (teplokrovnyh). *Trudy nauchnogo Himiko-farmacevticheskogo instituta. Vyp. 20*. M.: Izd. Nauchno-tekhnicheskogo upravleniya V.S.N.H., 1928: 73–80.
17. *Ivanyushkin AYa*. Al'bert Shvejcer: filosof, muzykant i vrach (tri ipostasi geniya). *Vestnik Moskovskogo gorodskogo pedagogicheskogo universiteta: Seriya "Filosofskie nauki"*. 2012; 2: 110–121.
18. *Chudakova M*. Zhizneopisanie Mihaila Bulgakova. M.: Kniga, 1988.
19. Sergey Sergeevich Bryukhonenko [Elektronnyy resurs]. URL: https://ru.wikipedia.org/wiki/Брюхоненко,_Сергей_Сергеевич (дата обращения: 23.07.2018).

The article was submitted to the journal on 26.08.2019