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PREFACE

In the latest issue of the "History of Science and Technology" journal, publications by authors from Canada, Ghana, Indonesia, Romania, Ukraine and Uzbekistan are presented. As always, we try to offer a wide variety of topics and areas and follow current trends in the history of science and technology.

In this issue, you will find interesting research that explores various aspects of the development of science and technology in different countries. The authors investigate different periods of history, ranging from ancient times to the present, and delve into both well-known events and lesser-known aspects that are worth studying.

The term Quale Mechanics is proposed by Romanian authors as describing the qualitative aspects of Quantum Mechanics that are susceptible of metaphysical considerations. The aim of Quale Mechanics is to distill the quantum discourse to its pillars in order to construct its proper – philosophical in nature – quale discourse. Quale Mechanics is proposed as a Weltanschauung that can be used as an aid to better grasp abstract notions of Quantum Mechanics by providing bridging links to Metaphysics. From a practical perspective, its use can be expected to ease the imagination process of a novice (possessing a Chemistry or Physical Chemistry background) that might



become beneficial for its creative quantum mechanical endeavours. Reversely – for a Quantum Mechanics initiated – Quale Mechanics can serve as a diving point into Metaphysics. Thus it has been shown that, within its underlying, Quantum Mechanics is not a revolution of thought, but merely a reiteration of a *Weltanschauung* previously shared by the ancient Greeks – a fruitful reiteration, nonetheless.

Choriyev and co-authors' paper is dedicated to the research of the documents on the history of the archives in Central Asia on the basis of archeological researches having been conducted in Central Asia over the last decades. Until now there have not been conducted practical complex studies of Central Asian archives of ancient times. On the basis of certain facts this following article has described the life experiences of ancient people who lived in the territory of current Uzbekistan and indicated the process of preserving documents and transferring data from generation to generation in the form of rock paintings and archival documents-libraries.

The article by Tetiana Hoshko is devoted to an exploration the flat cemetery near the village of Chornyanka, Kakhovka district, Kherson region, is one of the largest row grave fields of the Late Bronze Age archaeological culture of Bilozerkha in the northern Black Sea region. The cultural and chronological location of the Chornyanka burial ground was determined on the basis of an analysis of the main features of the funerary constructions, ceremonies and equipment.

The article by Kislov's analyzes the formation of theoretical views on the nature, methods, and practice of the administrative and communication activities of public authorities in relation to the people of the state in the VI–V centuries BC in Ancient China. Communication ideas have been identified, first of all, on the basis of analysis of Confucius' Lun Yu treatise. The conditions of the political and economic life of Ancient China promoting the emergence of the philosophical Confucian concepts of public administration and communication of that period have been shown.

The authors from Ternopil National Pedagogical University Volodymyr Hnatiuk analyzed the stages of creation, formation, development and modern activity of the Museum of Theater, Music and Cinema Arts of Ukraine, which is the only one in Ukraine in terms of its specialization. The article highlights typical problems and features that theater, film and music museums face in their activities.

The aim of the article by Verhunov's is to reconstruct the course of events and facts of scientist agronomist Serhiy Mykolayovych Bogoyavlenskyy's activity for the benefit of the development of agricultural science in Ukrainian lands, especially regarding the establishment and development of the Kyiv station for testing agricultural machines and tools during 1914–1916 based on the "personal files" found in the archives. Scientific novelty of the article lies in the fact that it examines information about one of the closest assistants of Professor K. G. Schindler in such a difficult, from an organizational point of view, matter of expanding the activities of the mentioned station.

In the article by Samuel Adu-Gyamfi and co-authors, on the basis of the complex analysis of sources and scientific literature the attempt to investigate the Trans-Atlantic Slave Trade which occurred between the fifteenth and nineteenth centuries and displaced Africans and people of African into the New World has been made. The trade

affected and influenced several aspects of the world economy, boosting the economies of participating countries and creating what would become the African diaspora.

In the following article, the authors reviewed the nuances of the organizational preparation the electrification of the Kharkiv plant of the Russian Locomotive-building and Mechanical Society.

Article by authors from Indonesia is devoted to study which examines clean water management in Bandung, West Java, Dutch East Indies (Indonesia), from the late 19th Century to the early 20th Century. This study focuses on how the human community has modified the physical water unit, including technology, management skills, and social and environmental priorities. Most of the data in this study were collected from primary sources in the form of archives, and official documents of the Department of Public Works and Bandung Municipality Government published in the late 19th century to the first half of the 20th century.

In the next article, the authors made an analysis on the history of creation and improvement of personal protective equipment.

This issue of the journal is completed by two reviews.

We are grateful to all the authors for their work and contribution to the understanding of the history of science and technology. We would also like to express our gratitude to our reviewers and the editorial team for their diligence and professionalism in the selection and preparation of these fascinating articles.

We hope that this issue of the journal will serve as a source of new knowledge, discoveries, and insights for our readers. We wish you an enjoyable and fruitful reading experience! And, of course, we welcome your new submissions.

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Quale mechanics as a metaphysical weltanschauung of quantum mechanics

Abstract. *The term Quale Mechanics is proposed here as describing the qualitative aspects of Quantum Mechanics that are susceptible of metaphysical considerations. The aim of Quale Mechanics is to distill the quantum discourse to its pillars in order to construct its proper – philosophical in nature – quale discourse. The framework of the discussion is initiated by revisiting the platonic approach of the manner in which knowledge is perceived/processed, and then by discussing the four sapiential stages before arriving at concept of the eide. The sensible-suprasensible dichotomy is exposed by contrasting aistheta to the eide. A discussion on the historical development and the foundation of the pillars of Quantum Mechanics is followed. This includes Planck's solution for the black-body radiation problem with the introduction of quanta – in conflict with Newtonian physics – followed by Einstein's explanation of the photoelectric effect and the implications involving the dual nature of light (particle vs. wave) and two generalizations of the quantum character of matter: the planetary model of the atom by Bohr, and the dual particle-wave character of electron demonstrated by de Broglie. The subsequent distillation of these semi-classical concepts into more abstract mathematical concepts by Heisenberg, Born, Dirac and Pauli are then reviewed – with Heisenberg's uncertainty principle and with the concept of wavefunction as landmarks that unmistakably departs from the classical deterministic view of matter. A representative illustration of these achievements is given by the Casimir effect – with implications for gravity and an illustration of how vacuum can in fact not be considered to be truly void. Quantum Mechanics, as the most*



accurate mathematical framework which can be employed in order to describe and predict the natural phenomena occurring at the atom-size dimensions of reality, may thus be considered as the root from which the concept of Quale Mechanics is emerged in order to construct the parallel between the metaphysical existence and the quantum physical wavefunction collapse. It is concluded that, within its underlying, Quantum Mechanics is a (hopefully fruitful) reiteration of the Ancient Greek Weltanschauung.

Keywords: *quantum; existence; wavefunction collapse; weltanschauung*

Introduction.

The challenges offered by science to personal beliefs (whether religious, political or of other types) are generally accepted to entail deep rooting into the subjects' *Weltanschauungs* (Boudry, Blancke, & Pigliucci, 2015; Hansson, 2017; Matute, Yarritu, & Vadillo, 2011; Shermer, 2011; Smith & MacDonald, 2017; Wallis, 1985; Shermer, 1997) As such, scientific reasoning may be (or is often) perceived as a challenge to the *Weltanschauung* itself rather than to any specific technical aspect/belief. The attitudes towards pseudoscientific topics such as vaccination, conspiracy theories, or pseudotherapies (e.g., homeopathy) illustrate such situations (Boudry, Blancke, & Pigliucci, 2015; Matute, Yarritu, & Vadillo, 2011; Schoijet, 2009; Shermer, 2011; Shermer, 1997; Silaghi-Dumitrescu, 2021a) Advocates of science in such contexts can be perceived as threats to a pre-existing *Weltanschauung* and thus be asked to provide a substitute – rather than simply demonstrate/convince that e.g. vaccines do not cause autism. It is at that point, and due to this challenge, that the subjects may demand of science to provide its own comprehensible view of the world – a *Weltanschauung* – or at least to manifestly support a preexistent one. The remarkable specialization tendencies in science do, however, mean that the same scientist that can demonstrate how vaccines are not connected to autism... will at most be qualified to look up the term *Weltanschauung* in a dictionary – but certainly not to do anything more than that. Such an ontological shortcoming from the part of scientists can not necessarily be seen as a sinful attitude, but rather as a natural byproduct of the hyper objectivity required by a healthy development of Science. Nevertheless, the problem remains that science may then be perceived as a cause for demolishing old worldviews but not so much as able to provide replacements thereof. Indeed, after the exciting and acceptable role of science in saving and/or improving billions of lives via vaccines, medicines, mechanization/automation, education etc. has unfolded, the realization of a missing sense of purpose can ensue and can foster resentment precisely against science – as previous *Weltanschauungs*, mostly religious and orthogonal to science, are manifestly outdated or unable to adapt to the new realities. As an illustration, some of the formerly communist (and notably secular and science-oriented) countries are prominently seen to collapse towards dire obscurantism (Silaghi-Dumitrescu, 2021a; Silaghi-Dumitrescu, 2018). It is also in these countries that the social collapse prior to the regime change from communism/socialism to democracy has entailed a manifest collapse of most branches of society – including the manner in which science is performed (Korotayev, Romanov, & Medvedev, 2019; Silaghi-Dumitrescu & Sabau, 2014). It is manifestly in such environments (though not

only there) that the questions are often asked: “What good are scientists nowadays? Are they not doing irrelevant and routine work (if any) that does not help our wellbeing and, in fact, only hurts our wellbeing by denying us the good-old (non-scientific) Weltanschauungs?” (Hansson, 2017; Florian, 2006; Silaghi-Dumitrescu, 2021b; Silaghi-Dumitrescu, 2021c). The level of distrust towards scientific endeavors is spectacularly illustrated by the degree of public acceptance of academic imposture in the form of plagiarized PhD theses of national leaders (presidents, prime-ministers, etc.); in one illustrative case, in one ex-communist country if one finds plagiarism in a PhD thesis older than a year, it is now unconstitutional to take any step towards retracting the respective PhD title (Abbott, 2012b, 2012a; Schiermeier, 2012; Strauss, 2014; Van Kline, 2022).

Science can thus be accused of adopting the role of substitute for the previous age-long religious-dominated Weltanschauungs. References to the Nietzschean deicide can be easily (though commonplace-superficially) invoked as reason for the science’s downfall into dogmatic paradigms – a manifestation which would of course be precisely opposed to science’s intended purpose. In its unsuccessful adaptation to the societal (laic) reality, this beheading may be argued to have caused voids within the collective unconscious that ultimately lead to a contamination of the scientific endeavor with the need to replace the now *headless serpent* with dogmatic belief in order to sustain the otherwise collapsing collective psyche. As natural things tend to avoid large gradients, this process would have preferred to avoid the drastic shifts within the collective psyche that are caused by a magnitude of the order of the Nietzschean-type deicide. Such gradients, for instance, can be tamed by employing philosophy-based Weltanschauungs so that their underlying transitions become smoother. Regardless of which Weltanschauung should be employed, the dramatic aspect of the current scientific status is represented by the general lack of adoption of any such worldview, lack which in turn provides favorable grounds for the adoption of dogmatic scientific reasoning in an unconscious manner to the point that, via the same unconscious regime, becomes the dogmatic part of oneself. Premise ultimately leading to a, safe to state, profane view of the world. In the words of C. G. Jung uttered almost a century ago (Jung, 1960, p. 467):

“The conception we form of the world is our picture of what we call world. And it is in accordance with this picture that we orient ourselves and adapt to reality. As I have said, this does not happen consciously. Nearly always a forceful decision is needed to tear the mind away from the pressing concerns of the moment and to direct it to the general problem of attitude. If we do not do this, we naturally remain unconscious of our attitude, and in that case we have no Weltanschauung, but merely an unconscious attitude. If no account is taken of our motives and intentions they remain unconscious; that is, everything seems very simple, as though it just happened like that. But in reality complicated processes are at work in the background, using motives and intentions whose subtlety leaves nothing to be desired. For this reason there are many scientists who avoid having a Weltanschauung because this is supposed not to be scientific. It has obviously not dawned on these people what they are really doing. For what actually happens

is this: by deliberately leaving themselves in the dark as to their guiding ideas they cling to a lower, more primitive level of consciousness than would correspond to their true capacities. Criticism and scepticism are not always a sign of intelligence – often they are just the reverse, especially when used by someone as a cloak to hide his lack of Weltanschauung. Very often it is a moral rather than an intellectual deficiency. For you cannot see the world without seeing yourself, and as a man sees the world, so he sees himself, and for this considerable courage is needed. Hence it is always fatal to have no Weltanschauung”.

Quale Mechanics is introduced here as an example of such a philosophical oriented Weltanschauung. The nomenclature is chosen as such in order to designate and to emphasize the *qualitative* nature and aspects of the formally established quantum discourse. The aim of Quale Mechanics is to distill the quantum discourse to its pillars in order to construct its proper – philosophical in nature – quale discourse. The reasoning behind its effort in achieving this shadow resonates with David Bohm’s suggestion (Bohm, 1980, p. XVI) for the use of the intuitive language in complementary to the logical one as means to achieve a harmonious functioning of the mind - a state of mind that would also be of benefit for the development of new theoretical ideas.¹

We embark, thus, by threading within the next two sections ancient Greek metaphysics and fundamental elements of Quantum Mechanics, alongside crucial aspects of its development, in order to prepare the mood for the quale discourse initiated in the fourth section. In doing so we have made use of Peters’ dictionary (Peters, 1967) for the ancient Greek related discussion; Hund (1974), Longair (2013), Piela (2014) and Atkins and Friedman (2011) were consulted when discussing the axiomatic system and the historical development of Quantum Mechanics. In order to better distinguish the Heideggerian *Being* from *being*, the latter was chosen to be expressed as *entity*. The English citations from (Blaga, 2013) are provided as personal translation from Romanian.

The four sapiential stages.

Knowledge can be revealed in different forms – and depending on the sharpness of the thought employed in order to open the abyss of truth, knowledge can be perceived at various levels of depth. According to Plato, there are four stages at which this perception of knowledge can occur (cf. Figure 1.a). The shallowest of them is termed εἰκασία (eikasia), representing a state which can be perceived only through images and reflections. The term itself derives from the word εἰκών (eikon), which can be translated to *image*, *face* or *reflection* (the same word represents the etymological root of the modern English word “icon”). As a first step involving the act of perceiving knowledge, it deals with images and their generation. The rather superficial character

¹ Our suggestion is that at each stage the proper order of operation of the mind requires an overall grasp of what is generally known not only in formal, logical, mathematical terms, but also intuitively, in images, feelings, poetic usage of language, etc. This kind of overall way of thinking is not only a fertile source of new theoretical ideas: it is needed for the human mind to function in a generally harmonious way, which could in turn help to make possible an orderly and stable society. (...) however, this requires a continual flow and development of our general notions of reality (Bohm, 1980, p. XVI).

of this step is best emphasized in Plato's words when he states that "the visible Universe is an εἰκών of the intelligible one, which comprise the εἶδη (eide = ideas)", and that "time is an image of eternity". The second step deals with the sensorial perception of the image and it is associated with the view developed from this process. This stage of perceiving is referred to as πίστις (pistis), a term which can be translated to *belief, faith, conviction* (the etymology of the word "piety" can be traced to the Latin equivalent of πίστις, *pietas*). These two steps differ from the next two the same way believing differs from comprehending (Heisenberg, 1979, p. 32). Consequently, the third step represents understanding and is termed διάνοια (dianoia). It also refers to *discursive thinking* and, in general, represents the type of knowledge that can be achieved with the help of sciences. Lastly, the fourth step is επιστήμη (episteme), which represents the true nature of things. This type of knowledge is in opposition to that of δόξα (doxa), which represents *opinions*, and, furthermore, Plato distinguishes επιστήμη from πρακτική (praktike = the science of action) and ποιητική (poietike = the productive science, art, poetry) as being of a pure theoretical nature. He puts the latter two terms at the same level with διάνοια, while he places the first one, δόξα, between the act of knowing the true things, i.e. επιστήμη, and ignorance, to which he refers the act of knowing about untrue things. Thus, the act of achieving an epistemic type of knowledge implies mining through the previous three levels of perception. Although at the dianoic level of knowledge a three-fold degeneracy occurs (cf. Figure 1.a), Plato's reasoning emphasizes the need of passing through διάνοια in order to reach επιστήμη, avoiding, thus, the other two, πρακτική and ποιητική. In other words, a symmetry breaking is required in order to remove the dianoic degeneracy such that the epistemic level of knowledge can be achieved, a symmetry breaking that quite resembles the Jahn-Teller effect of fame in modern physical chemistry. If in the latter (Jahn-Teller) case the geometry of a molecule is distorted along one of its symmetry axis such that a more energetically favorable state is achieved (cf. Figure 1.b), in the former, the 3rd level of knowledge is distorted along the "διάνοια axis" (cf. Figure 1.c) such that a deeper kind of knowledge (i.e. επιστήμη) can be achieved (cf. Figure 1.d).

The subtle difference between διάνοια and επιστήμη is exemplified in an enlightening manner by Werner Heisenberg in (Heisenberg, 1979, p. 32) where he notes:

*"Consider a man, whom we believe we know well, suddenly committing some misdeed which is at first quite incomprehensible. Those who know all the details of the case can then explain the reasons for his action. Thus we are in a position to deal with all the arguments, one after the other, and eventually, after a thorough investigation of these arguments we may understand the wrong he committed. This understanding corresponds to διάνοια. Or alternatively we may suddenly realize that this man **had** to act as he did. This sort of recognition can be described Plato's επιστήμη."*

Interestingly by the manner in which the outcome is revealed, the sudden epistemic recognition of the truth, which Heisenberg details in his example, resembles the *spontaneous* breaking of symmetry that implies the Jahn-Teller effect. Thus, in a ludic fashion, it can be asserted that the epistemic Jahn-Teller metaphor discussed above shares soil with Heisenberg's philosophic view. Regarding the role of modern

science, Heisenberg stresses that the physical explanation of Nature is a discussion aimed to distinguish *διάνοια* from *επιστήμη*. Regardless if the latter stage is achieved or not, it emphasizes the exclusion of the first two steps of knowledge from the domain in which scientific reasoning should manifest itself.

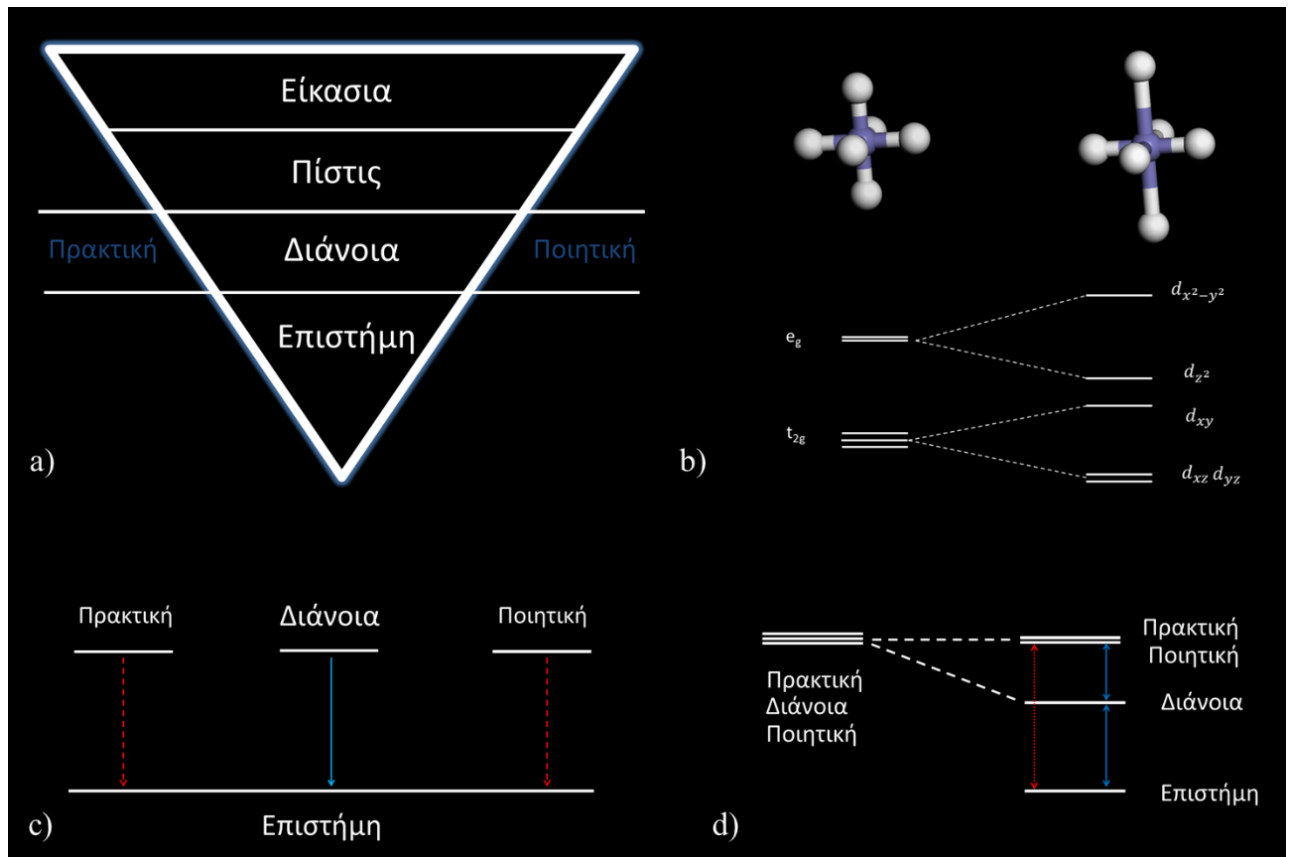


Figure 1. a) The Praktike-Dianoia-Poietike triple degeneracy; b) The Jahn-Teller effect depicted for a metal atom adopting an octahedral geometry; c) Forbidden and allowed transitions; d) The breaking of symmetry within the Praktike-Dianoia-Poietike degeneracy. Allowed transitions are depicted in blue while the forbidden one in red (Author's figure).

The *eide*.

Returning to the deepest level of perception of things, Plato believes that in order to reach the epistemic level of knowledge, the true nature of things needs to be known. In his view, the *εἶδη* (*eide*) constitutes the true nature of things that, like in the above-mentioned example regarding the intelligible Universe, are hindered behind appearance. The concept of *εἶδη*, of the indivisible and eternal entities that lay within the kernel of things, was developed in contrast with the pre-Socratic philosophy which, bearing Heraclitus as exponent, viewed change and fluctuation as the essence of Nature (cf. the famous Heraclitian aphorism *Πάντα ῥέει* = Everything flows). Consequently in this line of thought, as everything changes there is no true nature of things, the only constant in Nature being change itself. This fluctuation restricts the achievement of the epistemic level of knowledge and constrains the view of the world within the borders of illusion and temporal truths that are susceptible to fade as time prolongs. In this

framework, the highest act of knowing is represented by a πίστις → διάνοια transition. Plato rejected this framework as the fundamental view of the world and concluded that, in order to achieve the true form of knowledge (i.e. επιστήμη), the core of reality should not be subject to change. Interestingly, he refutes the somehow similar atomistic views of Democritus for being materialistic and in a suggestive metaphor he compares its followers to the Titans, while the Olympians are represented by the seekers of επιστήμη by means of transcending to a suprasensible picture of reality through the use of the είδη. Indeed a godly clash that dislocated the highest act of knowing from a πίστις → διάνοια transition to a διάνοια → επιστήμη transition...

The είδη represent the essence of things, the *ideas* that are the fundament of every object. They are of suprasensible nature, meaning that they cannot be grasped through sensorial means. Nevertheless, they can be reached through various rational processes, such as recollection (ανάμνησις) and different forms of dialectics (διαλεκτική). For instance, one of the first dialectical processes consisted in a regression from a hypothesis towards an unhypothesized principle, αρχή. Later, the dialectical process involved a collection/reunion (συναγωγή) followed by a primer division (διαίρεσις) which continues via a second, specific division (διαφορά) downwards the ultimate, indivisible είδος. Examples of eide are found in each class of things such as mathematics, in natural and artificial objects, in relations or even ethics, beauty, goodness. Some of the είδη play a more important role. For instance, for Plato the greatest kinds of είδη are the *Being*, the *Same*, the *Different*, the *Movement* and the *Rest*. By their nature, the είδη are transcendent and form the class of objects by which epistemic knowledge can be revealed. Their collection forms the τόπος νοητός, the intelligible place, are represented as the first concentric circle in Figure 2.

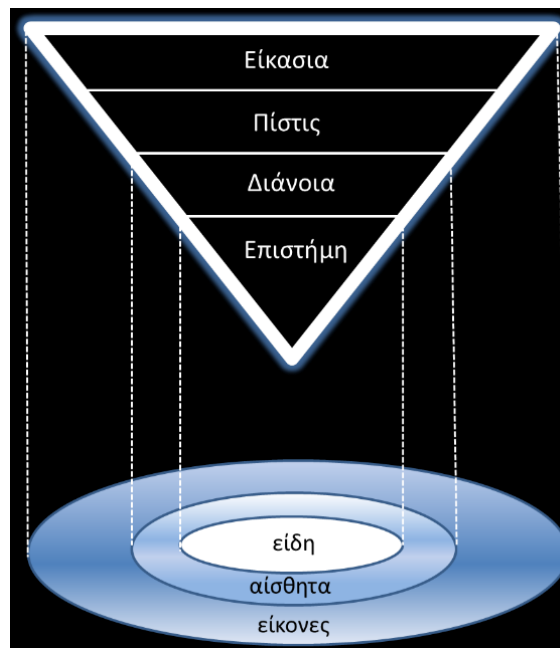


Figure 2. The classes of objects characteristic for different types of knowledge and their corresponding topos: τόπος νοητός in white; κόσμος and its illusory extension in blue (Author's figure).

Αἴσθησις (aisthesis) represents the sensible nature of things and the objects by which it can be perceived are referred to as *αἰσθητά* (aistheta). They are the source of sensation which, in itself, was regarded as the transition of a sensible entity from its potency (*δύναμις*) to its act (*ἐνέργεια*). Thus, the sensibles, *αἰσθητά*, are objects that are capable of being perceived. They cannot lead to an epistemic level of knowledge but are limited to a dianoic level of knowledge (cf. Figure 3) and therefore can only express opinions. They can still, however, retrieve a deeper level of knowledge than the *εἰκόνες* (eikones) which represent the images, reflections and shadows of things that are therefore restricted to *εἰκασία* and *πίστις* levels of truth. The topos of the sensibles (second concentric circle in Figure 3) bears a name that, through its modern meaning, also emphasizes the alteration that the ancient Greek concepts suffered through the ages: *κόσμος* (cosmos).

The transition from *εἶδος* to *αἴσθησις* is achieved through the intermediate class of the *μέταξύ* (metaxy) which, like the eide, are also eternal. The process itself was referred to as *μέθεξις* (methexis) which means *participation*. The difference between the eide and metaxy consists in the plurality nature which the later adopt. Such metaxy objects are represented by the objects of mathematics and geometry. For instance, the ideal numbers (*ἀριθμοὶ εἰδητικὴ*) are of such character and can modulate the transition between the world of the suprasensible and material world. In some aspects, this picture is not that different from our today's scientific method, which starts from empirical investigations of material objects and then bathes in mathematics in order to build models that can offer prediction. At this stage, more often than not, the similarity ends. The process is no longer descended towards the eide, but rather, in a boomerang manner, is redirected back towards the material world. Perhaps this is one of the crucial differences between us and the Elders. Often enough we restrain our mathematical endeavors to the practical aspects of reality and to its predictability. Blinded by the tempting shine of practical predictions, we ignore the underlying mysteries of the suprasensible world; we too often *shut up and calculate*.

Elements of Quantum Mechanics.

By the end of the 19th century, the Newtonian Mechanics had reached an undisputed status as governing ontological tool by which humankind could ultimately grasp the true nature of the physical reality and, therefore, nature itself. Indeed, the endeavor pursued by Newton's intellectual descendants such as Lagrange and Hamilton (who upgraded Newton's Mechanics) or Maxwell (who managed to provide a unitary description of the magnetic and electrical forces and therefore unite them under a common electromagnetic interaction) had managed to unveil the vast majority of mysteries hidden beneath the known-at-that-time aspects of Nature. There were, however, still some exotic phenomena such as the spectra of the black-body radiation and the emissions of atoms that were still not fully understood but were believed to be soon comprehensible by the virtue of Newtonian Mechanics. This atmosphere within the scientific world is perhaps best emphasized by the advice that Planck had received with regards to the study of physics: to abandon it as there is nothing left to be discovered beside these soon to be solved exotic issues (Lightman, 2009).

Planck can be regarded as still holding ground within the realm of Newtonian Mechanics, yet managing to provide a pivotal foot ground in the darkness lying ahead towards the suprasensible nature of what will later become Quantum Mechanics. Indeed, as it is often recalled, Planck's solution for the black-body radiation problem was the first shot in the dark; a shot that by hitting its target submitted the foundation of Classical Mechanics into a crisis. It was so because, in developing his explanation, Planck had hypothesized that the oscillating atoms constituting the walls of the black-body can transfer light only in discrete quantities of an elementary unit of light – a quanta. This was against Newtonian dogma that saw no reason for which this process should not be done in incremental amounts of light. Thus, while Newtonian Mechanics suggested a continuous range of energy by which the black-body radiation could be emitted, Planck's shot in the dark implied the opposite, that it can be emitted only in amounts of energy which were an integer multiple of an elementary energy.

It was in 1901 that Planck published his results, and the general impression under which they were received was skeptical. Planck's shot in the dark seemed as a fortunate accident and was regarded as a provisional result that was expected to be corrected and sustained within the Newtonian dogma. Planck himself tried to reconcile the two antagonistic approaches but it was too late. The shot in the dark he had taken provoked an avalanche. In 1905, Einstein further employed Planck's quanta hypothesis in order to explain the photoelectric effect. In doing so, Einstein brought confusion with regards to an aspect that was thought to be clearly understood, that is, the undulatory nature of light. Historically, Newton managed to establish the field of Optics by considering light as being of corpuscular nature. This was later shown to be incorrect by Huygens who, by treating light as an undulatory phenomenon, managed not only to reproduce the results of Newton's Optics, but also could provide explanations where the former failed: namely in the process of the diffraction of light. Thus the particle-like behavior of light, which was thought of as a particular description embodied in the general undulatory theory provided by Huygens, was revived by Einstein in his reasoning behind the photoelectric effect. The fundamental mystery that laid behind this effect consisted in the nature of the dependence that the ejected electrons displayed when removed from a light-ionized material. Namely, the number of such electrons (accountable by the intensity of the current that they were developing when connected to an electric circuit) was dependent on the frequency of the incident ionizing light and independent of its intensity. This was contrary to what one might expect from the undulatory behavior of light. Indeed, if light was to be of wave-like nature, the number of ejected electrons ought to be dependent on its intensity. This is so because the intensity of light is directly linked to the amount of energy it possesses and thus to the amount of energy available to kick electrons out of their hosting material. The dependence on frequency, however, implied that only some specific amounts of energy can yield electron ejections. Einstein managed to explain this frequency dependence by employing Planck's quanta of light as elementary particles constituting light itself. Thus, light appeared to behave in some situations as a wave and in others as particle. This aspect became known as the wave-particle duality of light.

The charge distribution within atoms was eventually clarified in 1911 when Rutherford, by scattering radiation upon atoms, managed to prove that atoms concentrate their positive charge in a point-like center, which is surrounded by a uniformly distributed negative charge. The positively charged nucleus was thus shown to be composed of protons and to be minute in comparison to the entire atomic volume, while the electrons formed the negatively charged medium that surrounded it and accounted for the vast majority of the atomic volume. In 1913 Bohr rationalized Rutherford's discovery in terms of stationary orbits that the electrons would adopt in their trajectories around the nucleus (stationary – with regard to the electromagnetic exchange that an electron ought to have with the surrounding medium when adopting these favorable orbits). From classical electrodynamics it was expected that an electron orbiting a nucleus would emit electromagnetic radiation due to being under a constant influence of the electrostatic force (and thus subject to acceleration; classical electrodynamics implies that an electric charge in accelerated movement would emit electromagnetic radiation). The loss of energy due to the radiating process would be responsible for a decrease of the electron's kinetic energy which would cause an imbalance in the favor of the centripetal electrostatic force. Ultimately, the electron would be doomed to collapse unto the nucleus. Bohr hypothesized that there ought to be some special orbits within which this radiative process would cease to exist (i.e. stationary states) and managed to explain the emission spectra of the hydrogen atom in terms of transitions between these stationary states. For instance, transitioning from a lower-energy stationary orbit to a higher-energy one, energy in the form of electromagnetic radiation would need to be added. Oppositely, an electron would output electromagnetic radiation when descending from a high-energy orbit to a lower-lying one. For all other infinite possible trajectories that an electron might adopt when orbiting the nucleus, the classical electromagnetic dogma would still hold as the electron would lose energy by emitting radiation but now, in its descend, would be caught in the safety-net of its proximal stationary orbit. Thus the planetary model of the atom was established and another anomaly was explained in terms of discrete phenomena (i.e. fixed values corresponding to interorbital transitions) as opposed to the continuous, incremental approaches adopted in classical physics. Furthermore, Bohr also showed that the stationary orbits that he hypothesized contained an amount of angular momentum which was an integer multiple of the constant that Planck had devised in his discrete description of the black-body radiation spectrum. It was the same Planck's constant that Einstein also used in explaining the photoelectric effect and that was now appearing in the motion adopted by the electron in the favorable, stationary trajectories inside atoms.

The wave-particle dual character of light was extended by de Broglie in 1924 to particles. It was in his PhD thesis where he showed that, under convenient circumstances, the electrons should behave like waves and diffract similarly to how light normally does. The same constant of Planck's appeared again. This time, however, it became clearer what it really is: the embodiment of the wave-particle duality itself, as it showed that for any given object, the amount of wave-like character

that the object possess (provided by its wavelength measure λ) and the amount of its particle-like character (provided by its momentum p) is constant:

$$\hbar = \lambda \cdot p. \quad (1)$$

The first mathematical formulation of Quantum Mechanics was established in 1925 by Heisenberg. The approach he adopted marks the end of the chimeric quantum-classical era (marked as the period of the Old Quantum Theory) and the dawn of the pure Olympian era of the Quantum Theory (also referred to as the New Quantum Theory). Heisenberg abandoned the concept of electron trajectories and relied solely on the observable quantities that were available from experiments. These were the energies of what Bohr called stationary states and Heisenberg associated them to virtual oscillators that were within the atom. He then coupled these virtual oscillators in terms of the transition energies known from atomic emission spectra. The revolutionary approach consisted in working with quantities which were associated with two states and not with one. For instance, when concerned with the trajectory of an electron within a stationary orbit, one might be interested in quantities such as velocity, position or momentum in terms of the energy associated with the respective stationary orbit. In other words, in quantities associated with a state. Heisenberg neglected these quantities and treated the known experimental data in terms of energies that coupled virtual oscillators corresponding to Bohr's stationary orbits, i.e. quantities associated with two states. In doing so, he stumbled upon a new quantum multiplication rule which, also to his dismay, was non-commutative in nature. Soon after he urged Heisenberg to publish his new approach, Born recognized that the non-commutative character of this new multiplication rule was similar to the non-commutative nature of some less familiar, exotic mathematical objects that he had encountered at some point earlier in his life: matrices. By this time, however, Heisenberg departed to Copenhagen, at Bohr's institute. Thus, Born had to ask his other prominent assistant, Pauli, to help him formulate in terms of matrices Heisenberg's approach. Convinced that the path of matrices will be just a mathematical complication, Pauli refused. He expressed this by warning Born that he will spoil Heisenberg with his mathematical endeavors. Nevertheless, Born was not disheartened and managed to spark the interest of one of his other pupils, Jordan. Together, in the same year (1925), they published the first formulation of quantum mechanics in terms of matrices. Heisenberg joined Jordan and Born, and together published, still in 1925, the paper that marked the birth of Matrix Mechanics. It was still 1925 and now Pauli redeemed himself by adopting and finally mastering the new matrix formulation. In doing so, he managed to discover two new fundamental quantum concepts: the two-valued nature of the electron with respect to a non-classical coordinate (which in the following year was observed experimentally and denoted as the *spin* of the electron) and the Exclusion Principle.

The following year, 1926, further marked the development of Quantum Theory. Firstly, Schrödinger adopted de Broglie's wave description of electrons and conceived in terms of wavefunctions a new approach to the quantum phenomena. His work on this subject marked the birth of Wave Mechanics. Then Born, again quick in reactions, provided within the same year the interpretation of Schrödinger's wavefunction as the

amplitude that when squared retrieves the probability of finding in a certain location the quantum object that it describes. Subsequently, Heisenberg formulated the Uncertainty Principle, which states that some quantum quantities cannot be simultaneously precisely known. Such quantities became referred to as complementary objects and could be identified by possessing mathematical descriptors which did not commute with each other. If the descriptors of two quantities commuted, then both quantities could simultaneously be known with precision. For instance, the position x and momentum p of a particle cannot be simultaneously known. Similarly, there is an uncertainty between the adopted energy in an interval of time:

$$\begin{cases} \Delta x \Delta p \geq \frac{\hbar}{2} \\ \Delta E \Delta t \geq \frac{\hbar}{2} \end{cases} \quad (2)$$

From 1926 to 1928, Dirac had managed to synthesize the newly developed quantum theories and then further provided his own crucial contributions to their development. He firstly demonstrated the equivalency between the matrix and the wavefunction formulations of Quantum Theory (together with the work of Jordan which became known as the Dirac-Jordan Transformation Theory; the equivalency, however, was also demonstrated independently by Schrödinger). He then managed to provide a connection, in terms of Poisson brackets, between Quantum Theory and the classical Hamiltonian Dynamics. His attempt to reconcile Quantum Theory with the Theory of Relativity led him to develop what was afterwards known as the Dirac equation. The relativistic treatment employed on Quantum Theory yielded, via this equation, in a natural way the concept of spin and also predicted the existence of antimatter.

At this point the ingredients for the foundation of a rigorous theory describing the quantum phenomena were set. The accomplished theory became known as Quantum Mechanics which, like other fundamental theories, is axiomatic in nature. The set of axioms adopted within Quantum Mechanics were based on the earlier results of the matrix and wave formulations and is comprised of six axioms.

The first axiom implies that each quantum state is characterized by a wavefunction, Ψ , which upon squaring retrieves the probability density associated with that state. All available information regarding the particular state is embedded within the wavefunction. For instance, if one might be interested in the position of particle within a certain state, the square of the wavefunction describing that state would map the space adopted by that state in terms of a probability of finding the particle in each point of the space occupied by the state. This axiom descends from Schrödinger's Wave Mechanics and Bohr's interpretation of the wavefunction.

The second axiom states that observable quantities are represented by mathematical operators that act upon the wavefunction. From a mathematical standpoint, these operations are done in a specific abstract space known as the Hilbert space. This axiom incorporates the essence of the earlier matrix formulation.

The third axiom assures that the evolution in time of a quantum state is described by the time-dependent Schrödinger equation:

$$i\hbar \frac{\partial \Psi}{\partial t} = \hat{H}\Psi, \quad (3)$$

where Ψ is the wavefunction describing the quantum state and $\hat{H}$ is the Hamiltonian operator.

The fourth axiom states that the result of a single experiment retrieves only one eigenvalue of the operator associated with the quantity sought by the experiment.

An eigenvalue problem implies that the outcome of an operator acting on a function will be the same function times a constant. If the function is represented by a wavefunction Ψ and the operator is generally noted as $\hat{O}$, then the eigenvalue problem can be written as:

$$\hat{O}\Psi = \omega_i\Psi, \quad (4)$$

where ω_i represents the entire set of constants that are solutions to the eigenvalue problem. The constants themselves are named eigenvalues and their set, referred to as spectrum, are specific for each operator. For instance, if the wavefunction describes the hydrogen atom, a Hamiltonian operator acting upon it will retrieve the (eigen)energies of the system: the energy of the 1s orbital, of 2s, 2p and so on. Thus, the fourth axiom implies that when trying to measure an electronic state within the H atom, for instance, one would obtain one of its available eigenstates (not two, not more). Both this and previous axioms are assumed from Schrödinger's wave-mechanical considerations.

The fifth axiom implies the existence of a spin degree of freedom for each quantum particle. This comes from experimental evidence. Like mentioned earlier, the relativistic treatment of quantum mechanics, however, retrieves the spin concept in a natural way.

The sixth axiom states that a wavefunction describing a set of bosons (=particles that possess an integer spin number) has to be symmetric while a wavefunction describing a set of fermions (=particles possessing a half-integer spin number) has to be antisymmetric. This implies that when exchanging the positions of two bosons, the wavefunction describing them remains the same:

$$\Psi_{1\leftrightarrow 2}^{bosons} = \Psi_{2\leftrightarrow 1}^{bosons}, \quad (5)$$

while for fermionic particles it changes sign:

$$\Psi_{1\leftrightarrow 2}^{fermions} = -\Psi_{2\leftrightarrow 1}^{fermions}, \quad (6)$$

This last axiom comes from experimental considerations which also provided the basis of Pauli's spin statistics.

Quantum phenomena are not restricted to discrete phenomena. In fact, the specific quantum discreteness appears only in bounded systems while for non-bounded ones particles can adopt a continuous range of states similar to the way they do in Classical Mechanics. For instance, an electron bounded to a nucleus will adopt a discrete range of energetic levels, while as a free-particle, such as in scattering experiments, the same electron can adopt a continuous range of energy states. In Quantum Mechanics the *Natura non facit saltus* classical dogma becomes *Natura ligatum facit saltus et natura liberum non facit saltus*.

An example encapsulating quantum phenomena can be given in the form of the Casimir effect. When two metal rods are placed in vacuum very close to each other (cf. the black bars in Figure 3), they experience an attractive interaction which, although small in magnitude, turns out to be far greater than if caused by gravitational attraction alone. The reason why they attract has been interpreted in a few ways – but among these is a pure quantum mechanical effect. Thus, in fact, the bars are not attracted to each other, but are being pushed to each other. This Casimir effect may thus be seen as an interplay of continuous and discrete states of matter embedded in Heisenberg's Uncertainty Principle. Due to the latter, vacuum may be interpreted to not be empty after all. Due to the complementary nature of energy and time, as shown in Equation 2, the uncertainty of one measure is coupled to the other. Thus for brief amounts of time, when Δt becomes very small, a significant fluctuation of energy, ΔE , may appear. The way in which this increase of energy manifests itself is by spontaneously generating pairs of particles and antiparticles that will exist for limited amount of time, Δt of Equation 2, after which they will annihilate themselves by recombining. The reaction between a particle and its antiparticle converts the full amount energy stored inside them in the form of mass, into pure energy in the form of photons. For instance, when an electron collides with a positron, two isoenergetic photons are released, each bearing a 0.51 MeV energy corresponding to the electron mass converted into energy via Einstein's $E = mc^2$. For a minute amount of time Δt corresponding via Equation 2 to the 1.02 MeV amount of ΔE , a pair of electron and positron will appear. Out of nowhere 1.02 MeV of energy is borrowed for the positron-electron generation, which will be repaid when the 1.02 MeV resulting from their annihilation returns back to nowhere. These transactions are allowed only during the Δt amount of time corresponding to the required particle-antiparticle energy. Due to the recurring generation-annihilation processes, the ground state energy of vacuum is higher than zero. Its inherent fluctuations cause a continuous range of energetic states that can be adopted. In the case of the Casimir rods, these positron-electron generation and annihilation processes occur in the vacuum outside rods as well in the vacuum between the two rods (cf. upper half of Figure 3). There is, however, a dramatic difference between the ways these processes manifest themselves outside the rods and between the rods. Confined within the region between the rods, the generated particles behave like textbook examples of particle-in-the-box systems and, similar to electrons confined in atoms, can only adopt a discrete set of energies. For the regions outside the

rods, particles are no longer confined as they are limited only in one direction by a rod. Consequently, they can adopt a continuous range of energies (lower half of Figure 3). Now, for each discrete energy state resulting between the rods, there will be an associated pressure exerted upon the rods. The pressure results from the occasional collisions between the particles corresponding to the discrete states and the walls of the rods. For each such discrete state between the rods, there will be an isoenergetic state outside the rods which will balance the rods by manifesting an equal amount of pressure from outside the rods. Furthermore, within the outside region there will be a continuous range of states between those corresponding to the discrete levels present between the rods. Consequently, the pressures associated with these non-discrete values of energies will not be balanced by corresponding pressures between the rods simply because the energies required by such pressures cannot be developed in a confined space (i.e. a bounded system). Thus, the overall pressure appearing outside the rods will exceed the one appearing between the rods and therefore will push the rods towards each other. The Casimir concept can be further elaborated to interpret gravitation itself, as done by Sernelius (2009).

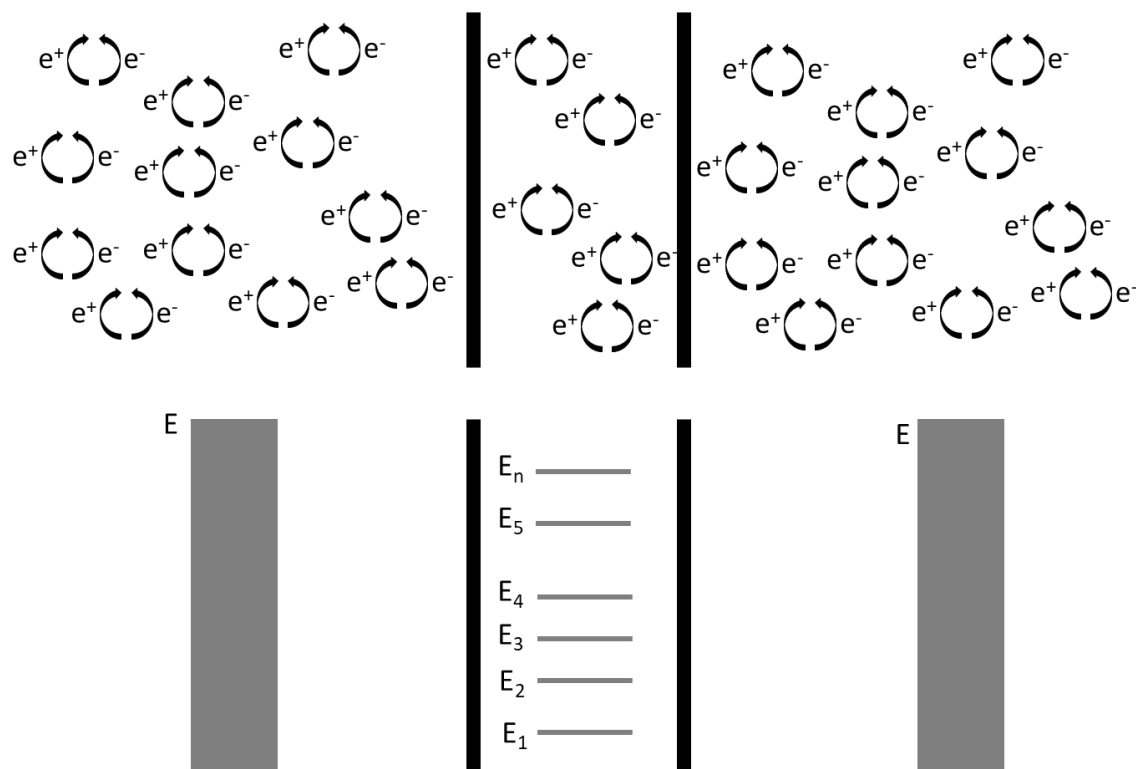


Figure 3. Depiction of the Casimir effect (cf. main text) (Author's figure).

Elements of Quale Mechanics.

By the term *Quale Mechanics* we refer to the qualitative aspects of *Quantum Mechanics* that are susceptible of metaphysical considerations. Quale mechanics can serve as a first hand approximation that can ease the understanding of fundamental quantum mechanical concepts.

Quantum Mechanics (QM) represents the most accurate mathematical framework which can be employed in order to describe and predict the natural phenomena occurring at the atom-size dimensions of reality. It represents the scaffold on which Quantum Theory (QT) resides the weight of its interpretations and the spring from which fields of quantic phenomena branch into technological applications.

A proposed hierarchical structure of Quantum Theory is presented in Figure 4. At the core of this classification lies the mathematical apparatus specific to this theory, coined “Quantum Mechanics”. This mathematical theory starts from an axiomatic system, dubbed the Quantum Mechanical Axiomatic System (QMAS), which is further developed into theorems and statements. Each mathematical proposition constructed within this framework adds to the size of the group. This growth can be pictured as an *encapsulated expansion*, as each new statement will extend the size of the group, but it will not bring any new information that was not hindered within the group’s essence (i.e. the QMAS). Mathematics is the tool that processes the QMAS inherent truth into aspects specific to certain situations.

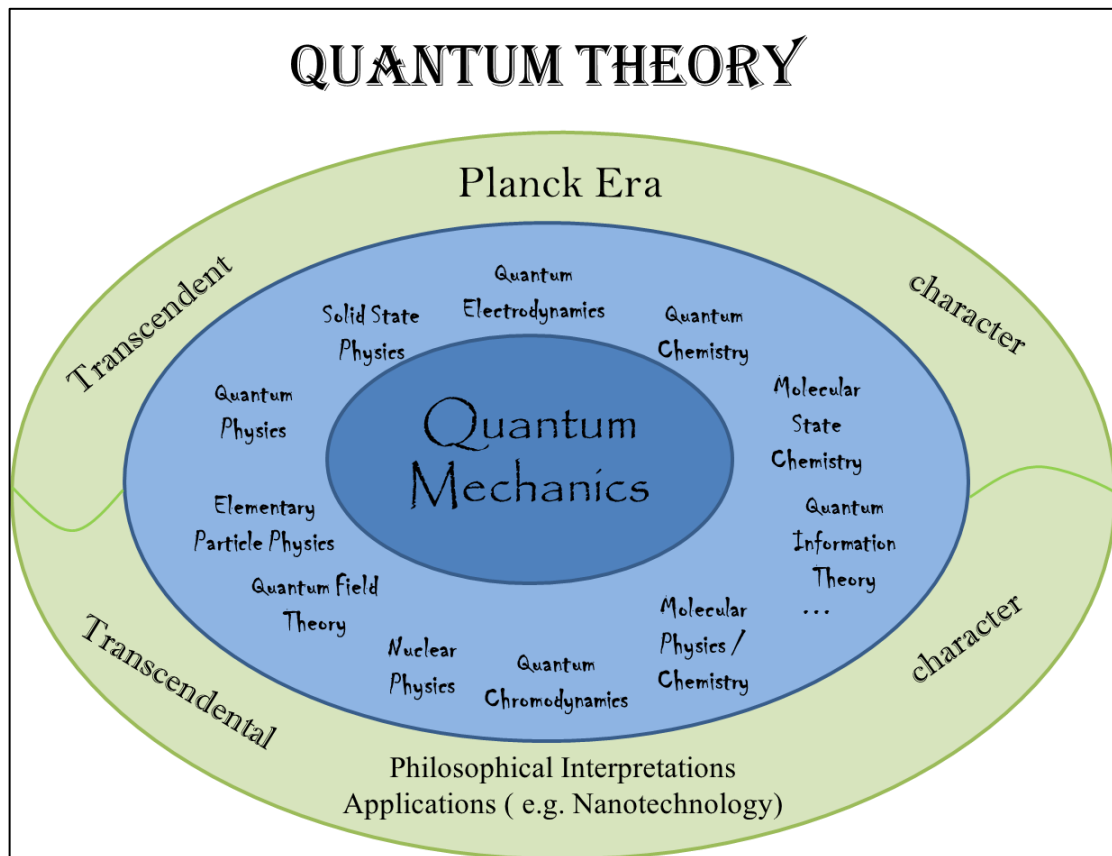


Figure 4. A hierarchical structure of Quantum Theory at the core of which lies the mathematical apparatus in the form of Quantum Mechanics. The second layer represents the further sprung quantum based scientific domains. The third layer denotes the two orientations the theory has: facing towards human perception and comfort are, respectively, its philosophical interpretation and its applications; facing toward its transcendent truth is the Planck Era of the Universe (Author's figure).

Quantum Theory is a generalization of Quantum Mechanics, not in a mathematical sense (because Quantum Mechanics is regarded as a closed system), but in the sense that the former is a global group in which the latter is part as a subgroup. For the QM case it can be asserted that an epistemological level of knowledge can be achieved because any complex “why” type of a question can be mathematically traced to its fundamental axioms. From the QM point of view there is no other truth laying beyond its axiomatic system and, although it can always be extended, it can be as closed (mathematical) system because all further-to-be-generated truth can be derived from previous generated truth and so on, further down to the zero-level unquestionable set of truths: to the QMAS. Within QM there is no other type of truth that is not *genetically* related to the QMAS.

On the other hand, the global Quantum Theory group also comprises that part of intellectual activity that casts the “why” question on the very essence of Quantum Mechanics (i.e. QMAS), namely the philosophical aspect of the “Interpretation of QM” subgroup. Applying the philosophical drill on the QMAS leads to its transcendence into a domain in which it can no longer be expected that an epistemological level of knowledge can be achieved. There is a two-folded reason why it can be stated that this has not been achieved, which may be presented in a Kantian manner as follows:

- from a transcendental point of view, i.e. from the point of view starting from the QMAS and heading towards the human preceptor (the observer), it has not been answered which of the QM interpretations (Copenhagen, Bohm – de Broglie etc.) is correct. As a matter of fact, recently it has been shown that neither of interpretations known to date can be correct (Frauchiger & Renner, 2018);
- from a transcendental point of view, i.e. from the point view departing on the opposing side from the QMAS towards a deeper essence of truth, it can be stated that all effects (including the QMAS itself) in the Universe can be traced back, cause by cause, to a cause that will eventually had to be taken place prior the Planck time, in a time in which all human-conceived theories are no longer valid.

From a philosophical perspective, the Planck Era of the Universe can be regarded as the matrix of *mystery* and the primeval source of what Lucian Blaga refers to as “*luciferian knowledge*” (Blaga, 2013). Through this term, the philosopher considers that type of knowing by which “*through the initial act, it (i.e the luciferian knowledge) considers its object cleaved in two, in one part which reveals itself and in one which conceals itself. The object of luciferian knowledge is always a mystery, a mystery which through its signs, on the one hand, reveals itself and on the other conceals itself*” (Blaga, 2013, p. 253).

In Blaga’s philosophical system, the *luciferian knowledge* is complemented by the *paradisiac knowledge*. The terminology used by Blaga is strictly restricted to its etymological sense. Namely *luciferian* is used with its original sense, that of *bringer of light* (the etymology of the word is found in the Latin words *lux*, meaning light, and *fero*, meaning carrier, bearer). On the other hand, the *paradisiac* term borrows its mythological sense and reflects the *illo tempore* condition “when” everything was in good order, everything in equilibrium and furthermore everything was *known*. Perhaps an example can elucidate the meaning and usage of these two terms. Let us consider a

celestial object that can be visible on a night sky. We assume that no astronomical instruments are at our disposal so that, in observing the celestial object, we rely solely on our eyesight. In this configuration, the celestial body can be regarded as a mysterious object subject to a luciferian type of knowledge in the sense that the light arriving from it offers positivistic aspects regarding its location and brightness, but simultaneously the same arrived light is the factor that obscures the object's essence. Thus, although some aspects of its being are revealed, its nature remains hindered to us and we cannot know exactly if the celestial body is, for instance, a star or planet Venus. In Blagian words, the sign by which the celestial object manifests itself simultaneously reveals and conceals its characteristic aspects. This line of thought can be extended as the technological and theoretical instruments required for understanding the celestial body evolve. For instance, it might be shown that the object is in fact a star and now the mystery is further descended to the question "how does it produce the light by which it is seen?" Upon understanding that the respective light is produced by nuclear fusion, the mystery is shrunk to the question "why does nuclear fusion produce light?". This can be understood from the perspective of the Special Theory of Relativity (STR), which provides the equivalency between matter and energy together with the law that governs their transformation (i.e., $E=mc^2$). From STR's perspective, the now acquired information is of an epistemological level because this transformation law can be decomposed to STR's axiomatic system. For instance, one such axiom would be that light travels at constant speed in all relative reference systems. Within the STR framework the question "why does light travel at a constant speed regardless of reference system?" is an invalid question because its domain of applicability lies outside that of STR. Thus, from STR's perspective, the knowledge has reached an *επιστήμη* level that corresponds to a paradisiac type of knowledge as all that can be known, within STR's boundaries, is known. Pushing the question outside the STR domain would require a further (more profound?) theory in which, now, the STR-epistemic knowledge would be degraded to, at best, a *διάνοια* level.

Now we are left with the impression that the pursuit of knowledge itself could be painted via encircled cycles which, by concentrically collapsing within themselves, provide the transition towards more fundamental stages. This picture in itself implies a fundamental axiom that governs all axiomatic systems of each theoretical stage: that within each stage there are at least two levels of knowledge, one corresponding to *επιστήμη* and one to *διάνοια*. Perhaps at one point, a stage in which all available knowledge is of *επιστήμη* nature and thus, this axiom among axiom might also lose its domain of applicability. Nevertheless, each of the aforementioned steps employed in the transition between the stages of acquired knowledge, from simply observing the celestial body all the way to the axioms of Special Relativity, correspond to what Blaga refers to as the *crisis of the object*. The act of questioning the *paradisiac* pillars of the theory triggers a crisis that, by deepening the foundation of the *paradisiac* theory into mystery, becomes the basis of the new *luciferian* knowledge.

Converged to the Planck Era is also the metaphysical endeavor towards fundamentals. In this case, similar to the space bordering a black hole's horizon that

generates² Hawking radiation “out of nothing”, (Hawking, 1975) the space-time region corresponding to the Planck Era can be seen engulfed within the fundamental question of metaphysics: *why is there entity instead of nothingness?* The domain of this question covers all that is, was and will be within the Universe and ends where it can no longer be asserted about anything as being Being: the Planck Era. As put by Heidegger: “*The domain of this question is limited only by what simply is not and never is: by Nothing. All that is not Nothing comes into the question, and in the end even Nothing itself—not, as it were, because it is something, an entity, for after all we are talking about it, but because it "is" Nothing.*” (Heidegger, 2000, p. 2) The true Nothing is that out of which the Big Bang presumably commenced (as explained for the Casimir effect, the vacuum is not really empty, is not a *nothing*). Furthermore, the Plank Era is the only era which is limited at one end by Nothing and at the other by something in which entities exist. By continuing this line of thought, we can identify two types of eras from now on. One of them (a single era in this category) starts from the end of the Planck Era and lasts for as much as needed for an entity to come into existence. Thus, this era belongs to something that has entity and, being the first of this kind, is limited on one side by the Planck era and at the other by something that has entities. From here onwards, all eras, no matter how divided, will always be delimited by entity-containing eras. How does that first entity come into existence? Physically, it just transitioned from the previous era in the form of the primeval radiation and can be imagined as a collision of two photons generating matter in the form of particle-antiparticle pairs. By having converted energy into mass, space and time come as byproducts of this process (from the General Theory of Relativity it is known that space and time cannot exist in the absence of matter, just as well as matter cannot exist in a framework outside space and time), and from now onwards the space-time stage is set for all entities to exist. Metaphysically, existence implies the transition from *Being* to *Entity*, the manifestation of a *Being* through *Entity*. To better understand the difference between the two latter terms we can follow one the subtle examples provided by Heidegger:

“Over there, on the other side of the street, stands the high school building. An entity. We can scour every side of the building from the outside, roam through the inside from basement to attic, and note everything that can be found there: hallways, stairs, classrooms, and their furnishings. Everywhere we find entities, and in a very definite order. Where now is the Being of this high school? It is, after all. The building is. The Being of this entity belongs to it if anything does, and nevertheless we do not find this Being within the entity. Moreover, Being does not consist in our observing entity. The building stands there even if we do not observe it. We can come across it only because it already is. In addition, the Being of this building does not at all seem to be identical for everybody. For us, as observers or passers-by, it is not what it is for

² In terms of the same uncertainty considerations explained for the Casimir effect (cf. Figure 3), the vacuum surrounding a black hole will generate pairs of particles and antiparticles. At the black hole's horizon, i.e. the region of space from which nothing can escape its gravitational attraction, the pairing will be disrupted: one of the generated particle will be initially oriented towards the black hole and by passing through its horizon will not be able to return to its partner particle and annihilate; the paired particle, initially being oriented oppositely to the black hole, will have the chance to evade its gravitational sink. The net result is called the Hawking radiation (being formed from the evaded particles). The swallowed antiparticles will eventually lead to the black hole's evaporation.

the students who sit inside, not just because they see it only from the inside but because for them this building really is what it is and how it is. One can, as it were, smell the Being of such buildings, and often after decades one still has the scent in one's nose. The scent provides the Being of this entity much more directly and truly than it could be communicated by any description or inspection. On the other hand, the subsistence of the building does not depend on this scent that is hovering around somewhere" (Heidegger, 2000, pp. 35–36).

For the ancient Greeks, *being* meant either something standing in itself, when referred to by *φύσις* (fysis), either something constant, enduring, when referred to through the word *οὐσία* (ousia). To exit from such a state meant to no longer be and the word used to describe this was *ἐξίστασθαι* (existasthai).³ To bring a being into existence means to transpose it into an entity. Thus, the original, Greek meaning of existence implied to no longer be. Similar to how in the quantum mechanical language, upon measurement, a wavefunction expressed in the Hilbert space collapses into one of its eigenstates expressed in the real space (i.e. fourth QM axiom), in the language of metaphysics bringing a being into existence collapses it into entity. Similar to how a wavefunction cannot be directly observed, but only grasped through its manifestation upon collapsing into to real space (and further observed via a quantity derived from its square modulus), the metaphysical *being* cannot be physically reached but only grasped through its entity manifestation. Both *being* and wavefunction, however, can be reached and tangled through the human intellect. Both are of suprasensible nature and are susceptible in collapsing into sensible manifestations (cf. Figure 5).

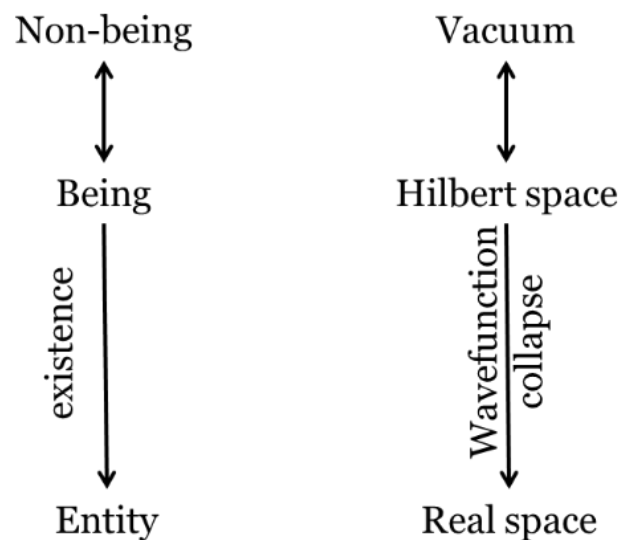


Figure 5. Parallel between Metaphysics (left) and Quantum Mechanics (right) (Author's figure).

In its uniqueness, the *Being* is only matched by the *non-Being* (Heidegger, 2000, pp. 80–84). The two concepts find themselves in a complementary relationship similar

³ Perhaps the etymology of the English word “exit” might be traced to the Greek *ἐξίστασθαι*.

to the complementary quantities appearing in the uncertainty relationship responsible for the vacuum generation of virtual particles and antiparticles.

Being of suprasensible nature, the *Being* can be asserted within the *τόπος νοητός* (topos noetos) and therefore sharing ground with the eide. The *entity* on the other hand, is by the virtue of its sensible nature an object within the *κόσμος* (cosmos) and therefore sharing ground with the aistheta. Thus a third parallel represented by the eide-aistheta binomial can be traced to the previous two parallels. Now, the fully deterministic wavefunction expressed within the Hilbert space can be translated to an ancient Greek as a sort of eidos belonging to the *τόπος νοητός* that by collapsing, in a similar way to which the eide enter in *participation* (methexis), can be observed within the real space similar to how an aistheton is sensed within the *κόσμος*.

Conclusions.

Quale Mechanics is proposed as a Weltanschauung that can be used as an aid to better grasp abstract notions of Quantum Mechanics by providing bridging links to Metaphysics. From a practical perspective, its use can be expected to ease the imagination process of a novice (possessing a Chemistry or Physical Chemistry background) that might become beneficial for its creative quantum mechanical endeavours. Reversely – for a Quantum Mechanics initiated – Quale Mechanics can serve as a diving point into Metaphysics.

Throughout the text it was followed how the discrete was discerned from the continuous in order to arrive at the construction of the parallel between the metaphysical *existence* and the quantum physical *wavefunction collapse* (cf. Figure 5). Thus it was shown that, within its underlying, Quantum Mechanics is not a revolution of thought, but merely a reiteration of a Weltanschauung previously shared by the ancient Greeks – a fruitful reiteration, nonetheless.

For future development, one may further explore the influence of the sensible-suprasensible dichotomy on the history of the development of science, with particular emphasize to its impact on the Quantum domain.

“*It is the study of the Chemists to liberate that unsensual truth from its fetters in things of sense*” was once said by the alchemist Dorneus (Jung, 1959, p. 201). With respect to this view of Dorneus, Quale Mechanics – as presented here – is a study of the *Chemists*.

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Conflicts of interest.

The authors declare no conflict of interest.

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Quale механіка як метафізична світоглядна концепція квантової механіки

Анотація. Термін "Quale Механіка" запропоновано тут для опису якісних аспектів Квантової Механіки, які піддаються метафізичному розгляду. Мета Quale Механіки полягає в тому, щоб упорядкувати квантовий дискурс до його основних засад, щоб побудувати його власний – філософського характеру – Quale дискурс. Рамки дискусії розпочинаються поверненням до платонівського підходу до способу сприйняття/обробки знань, а потім обговорюються чотири стадії до досягнення поняття ейдосів. Природа відчуттєво-надвідчуттєвої дихотомії викривається шляхом протиставлення айстетичного ейдосу. Далі йде обговорення історичного розвитку та основ Квантової Механіки. Це включає розв'язання проблеми чорного тіла Планком з введенням квантів – у конфлікті з Ньютонівською фізикою, а потім поясненням Ейнштейном фотоефекту та наслідками, пов'язаними з подвійною природою світла (частинка проти хвилі) і двома узагальненнями квантового характеру речовини: планетарна модель атома Бора та подвійна частинково-хвильова природа електрона, продемонстрована де Бройлем. Подальше упорядкування цих напівкласичних концепцій в більш абстрактні математичні концепції Гайзенбергом, Борном, Діраком і Паулі потім розглядаються з принципом невизначеності Гайзенберга та поняттям хвильової функції, які недвозначно відходять від класичної детермінованої картини матерії. Прикладом цих досягнень є ефект Казимира – з його наслідками для гравітації і демонстрацією того, що вакуум насправді не можна вважати повністю пустим. Квантова Механіка, як найточніша математична рамка, яку можна використовувати для опису та передбачення природних явищ, які відбуваються на атомних розмірах реальності, можна розглядати як корінь, з якого виникла концепція Quale Механіки для побудови паралелі між метафізичним існуванням і квантовим фізичним згортанням хвильової функції. Зроблено висновок, що, в основі своєї, квантова механіка є повторення Античного Грецького Світогляду.

Ключові слова: квант; існування; згортання хвильової функції; світогляд

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The history of archives in Central Asia: ancient times

Abstract. *The article devoted studies of the documents on the history of the archives in Central Asia on the basis of archeological researches having been conducted in Central Asia over the last decades. Until now there have not been conducted practical complex studies of Central Asian archives of ancient times. On the basis of certain facts this following article has described the life experiences of ancient people who lived in the territory of current Uzbekistan and indicated the process of preserving documents and transferring data from generation to generation in the form of rock paintings and archival documents-libraries. These references indicate to the existence of ancient scripts in Khorezm. On the basis of scientific studies of the scientists it can be concluded that the elements of scripts discovered on the ancient ceramic handcrafts may be considered as the samples of early economic archives found in the territory of present Uzbekistan. In the period of Akhamanids in Iran and in Central Asia cuneiform was widespread and in the whole territory of the empire Aramaic script wasn't the only language of paperwork. As it has been indicated in the article, according to its geographic scope, the Bactrian language took the second place after the Sogd language which was widely used in the territory extending from India to Eastern Turkestan. The fact that two biggest empires as Kushanids and Ephtalits and then also the state of Takhirids utilised this script demonstrates the significance of the*



ancient Bactrian language in the lives of ancient nations. This paper also shows the similar attributes of the Bactrian language used in making negotiations of Surkh-Kutal, Rabotak with the scripts used in the samples of the letters in the documents from the library of Ashurbanipal and with the Het script in which the texts of the anthems, national communal decisions and religious messages were inscribed on the rocks. There are also some evidences proving the existence of particular archives in the residences of ancient rulers of Central Asia in such places as Toprak Kala (Khorezm), and in the mount of Mug' (Devashtich archives). Particularly in royal archives there was a systematic archival work and such materials as leather and wood were widely used to fix the data. Such documents as personal letters, diplomatic correspondence, contracts and economical records were kept in this period. It also should be noted that paperwork was far more enhanced in this epoch.

Keywords: Sopollitepa; Jarkutan; pictography; Ancient Khorezm; Sugd; Devashtich archive

Introduction.

These days many reforms have been done in the field of archives on the world scale and a special attention is being paid to historical and national archives which are considered to be an attribute of the country.

There is no single conception of archival work. Many transformations have been carried out in the administrative systems of the countries after World War II. The modernization in archival field of the United States have surely impacted the sphere of archives in many countries. The end of the slavery in Latin America gave an impulse to the formation of novel principles of statehood in the continent which in its turn laid a foundation for new principles in the sphere of archives (Betancur Roldán, 2022).

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The documents which were kept as confidential, constitute a certain proportion of all the documents. Additionally, they are constantly stored in the archives and are considered as pivotal historical data which serves as main information source for the subject of History. Earnest transformations have taken place in the assortment of archival documents in such countries as the United States, Great Britain and partly in France, Germany, Sweden and in the countries of Central Asia after World War II (Čtvrtník, 2022). This particular process began in Uzbekistan in 1991 when our country got its independence.

Nowadays a lot of works are being done in preparing personal for the field of archives and also studies are being conducted in the history of the formation of work

ethics and order in archival works and a lot of efforts are being done to master these accomplishments (Vallejo Sierra & Morillo, 2022).

According to the research works of some scientists, modern archival works are developing in the form of “Big data” which encompasses texts, photos, audios, videos and similar information. “Big data” is successfully utilized in many spheres such as medicine, transportation, media, governmental establishments, the Internet, retail industry and so on (GUO Wei-ya, 2021).

International Archival Convention of France is constantly making a lot of efforts to encourage specialists to study the documents in the archives and to estimate their significance, to preserve archival heritage and to utilize them. Nowadays a special attention is spared to the studies of the history of archives and contemporary archival works in the developed countries of the world (Kretzschmar, 2013, pp. 5–9).

In the decree of “Action Strategy” that has been signed by the president of Uzbekistan to establish 5 important Uzbekistan’s Development Strategies for 2017–2021, it is mentioned to “encourage scientific researches and innovation activities, to put into practice effective mechanism of achievements” (National database of legislation of the Republic of Uzbekistan, 2017, February 08), and to implement the latest technology. Above mentioned factors are strictly taken under control to learn and investigate the history of Uzbekistan via primary archival sources.

Especially, the research which has been carried out about the archival history of ancient times holds a big significance in making clear topics that are related to nationhood and governmental issues. The verdicts and decisions of the Republic of Uzbekistan such as: decrees about “Archival works” (2010), the cabinet of ministers of the Republic of Uzbekistan “Approving normative archived documents” (1999, October 30, No. 482), “Extra actions to improve archival field in the Republic of Uzbekistan” (2008, August 26, No. 194), “Development of archival field in the Republic of Uzbekistan” (2012, April 5, No. 101), “Storing handwriting sources of the president of Uzbekistan and implementing investigational and promotional actions” (year 2017, May 24) are playing an important role in effective completion of above-mentioned tasks.

Today there are no research works on the archives of ancient times of Central Asia and Uzbekistan. The researches done on the history of archives of ancient times may clarify many things related to the history of statehood which is indeed a very actual topic.

Research methodology.

The methodological basis of the work is a number of historical studies. The article applies the method of critical analysis of archaeological research materials related to the history of ancient archives. The findings presented in this article are arranged in chronological order. Also, paleographic source studies, textological, archival methods of scientific research are used in the work. This approach provides an opportunity for objective coverage of the historical processes of formation and development of ancient archives in Central Asia and, in particular, in Uzbekistan. In the process of working on the topic, the principles of objectivity and impartiality occupied an important place,

which helped to assess the history of the archives of ancient times in Central Asia and Uzbekistan. Thus, an integrated approach in the application of various scientific research methods, used by the authors in preparing this article, helps a systematic and more versatile disclosure of historical realities in the history of the ancient archives of Uzbekistan.

Results and discussion.

Theoretical views about archives of ancient times.

The history of Central Asia, including the history of Uzbekistan scopes many thousands of years and the research conducted in dozens of settlements of people who lived here also proves this notion.

According to the theoretical concepts, archives were preserved in the form of archival libraries all over the world. When we talk about this field it is worth mentioning that today petroglyphs and mural paintings belonging to the primitive ages are being perceived as archival data. Such theoretical concepts are also forwarded that in ancient times when speech and writing ethics were not developed, in order to pass their practical experiences to the next generation, people used to deliver messages about hunting methods, religious practices and parties, and also farm life processes via not only wall and rock paintings, but also with the help of stone, wood, bone, ceramic and iron (Karapetyants, 1997, pp. 3–12). Such rock and cave paintings have been preserved in places like Sarmishsoy area in the city of Navai, Ohangaron in Tashkent district, Zarausaroy in Surkhandarya district.

The notion about the coinciding origination of the first statehood and the archives in Uzbekistan was put forward by the Uzbek archival scientist I. Alimov. As a rule, when any state was established, rules, regulations and laws were legislated and they were specially kept in order to rule and control the state. Hence, archives came to existence as a separate field in Uzbekistan. According to the research, the inscriptions of “Avesto” were also considered to be an archival data (Alimov, 2004, pp. 3–5).

Texts bearing historical and documented information are the key elements of archival documents. And the script is considered to be a pivotal element to record the data. While some people think that handwriting is an essential sign of civilization, another group of people are of the opinion that the formation of the cities, monumental temples and the castles is the main indicator of the development (Shaydullaev, 2009, p. 139).

In IV–III BC in Mesopotamia the very early handwritings appeared in the form of paintings and later it turned to cuneiform (an ancient wedge-shaped script). At the end of the 3rd millennium BC Egyptian hieroglyphics came to an existence which coincided with the creation of the inimitable Egyptian kingdom (D'yakonov, Neronova, & Svencickaya, 1983, pp. 12–30). In the history of the humankind the very first handwriting based on letters was founded by the Phoenicians at the end of the second millennium BC and this handwriting served as a ground for the origination of the Aramaic and Greek alphabets. It is acknowledged that Greek, Chinese, Aramaic, ancient Bokhtari, Khorezmian, Sogdian handwritings had been put into practice until the introduction of the Arabic handwriting in Central Asia (Rtveladze, Saidov, &

Abdullayev, 2000, pp. 89–123). The most ancient handwriting is considered a short Aramaic handwriting inscribed on the vase dating back to VI–V centuries BC found in Aybuyirkala memorial in ancient Khorezm. Also, messages and texts written in Aramaic handwriting were found in Kuykirilganqala, Amurdarya.

The most ancient pictographic handwriting was found in Sopollitepa memorial in Uzbekistan and an item with 29 signs were discovered there. They were divided into 8 groups according to their shapes by scientist A. A. Askarov. The first group of signs were in the form of half moon, and quite similar signs were found in another 4 items. There is a sign of drawn bow in the second group, in the center of it there was a perpendicular straight line. The exact 5 pretty similar shape-signs were found in Sopollitepa. Parallel lines were found with 6 signs by the third group of people. There was a straight line connecting with the third parallel line which resulted in the constitution of the letter “N”. The signs of fourth group were in the form of crop and they are only 4. The signs of the fifth group were described on one dish and it is straight line which connects two circles. We can call this sign as “a cart”, because in Central Asia the picture of “a cart” is demonstrated in exact way on rock paintings. When it comes to the sixth group of the signs, it’s similar to the first group as their shape is in the form of the moon but there is a difference as the moon there is a lot more bowed. The seventh group of signs reminds the letter “A” as 3 similar signs were found. The eighth group represented the shape of a snake and there were pictures of a snake on two ceramic items (Shaydullaev, 2009, p. 142).

It’s a little bit complicated to say what is the clear meaning of the pictures represented on these items and the scientists differ in their opinions concerning them. It is scientifically proved that the signs written on the items are the very first pictographic handwritings. In ancient eastern history, handwritings were gradually formed undergoing several stages. As it has been mentioned above, people delivered their opinions, thoughts, elements of their lifestyles in the form of paintings and signs. The signs in Sopollitepa and Jarkutan are of a big example of it. Similar to the ceramic era, in this era pictographic signs can be seen on ceramic dishes, like on vases, pitchers and kaskans. Until today, 52 kinds of inscribed sign-writings that belonged to Jarkutan area have been found. Some signs were repeated 2–3 times. However, a lot more signs have been written only once and they are irreplaceable.

The sign of cross is one of the most constant and repeated sign in the era of Jarkutan among pictographic sign-writings. The sign of cross is not only applied on ceramic items but also was widely described on amulets and seals in ceramic. The sign of cross was extensively used as pictographic handwriting. We can also see this in Egyptian pictography in the form of hoe and plow (Shaydullaev, 2009, p. 145).

The fact that representatives of the population kept records of information or texts related to agricultural farming life, and the occurrence of this type of inscriptions on seals indicates that this economic sector has become important even at the city-state level.

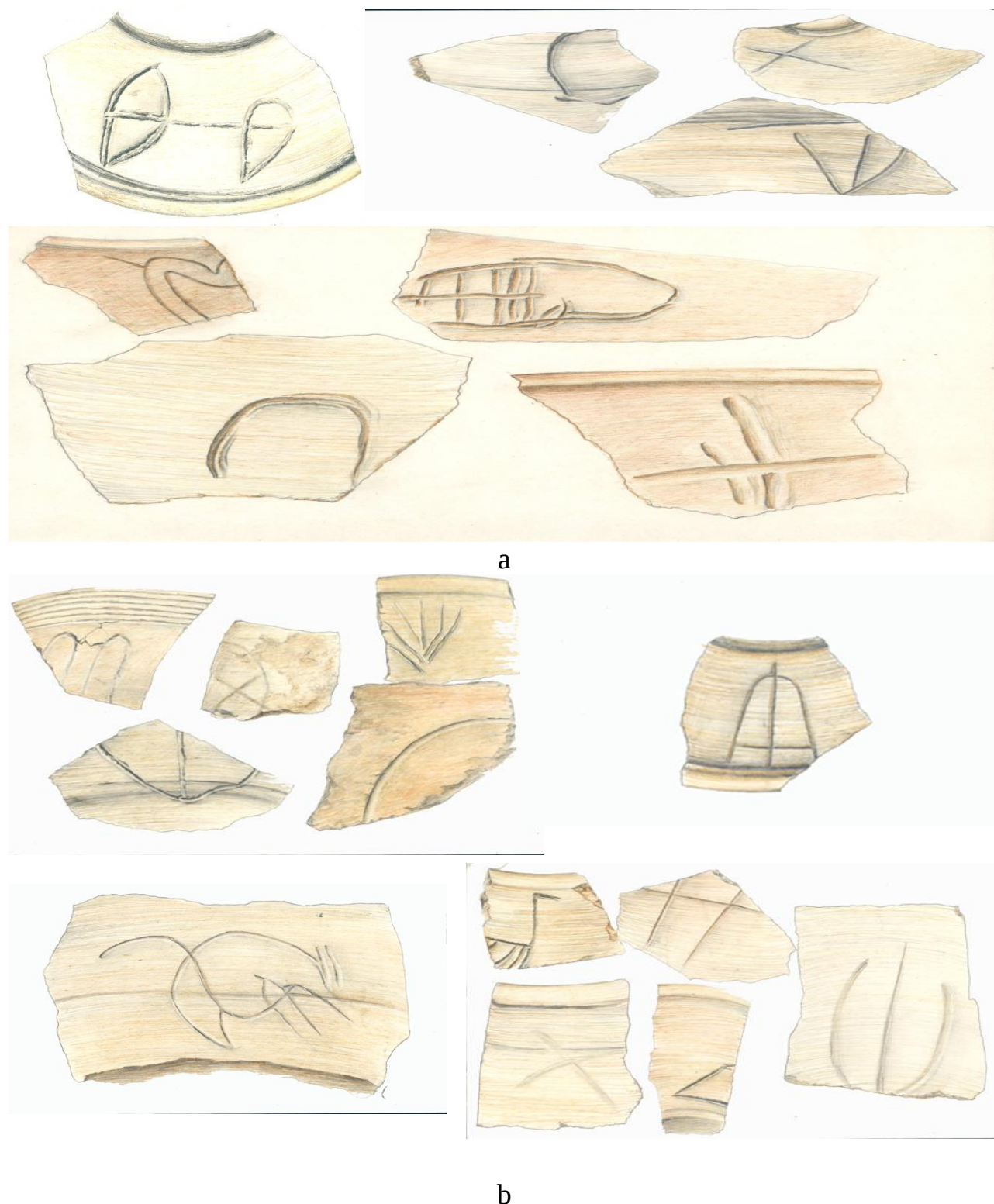


Figure 1. Pictographic signs (Sopolli culture): (a) – (Choriyev, Shaydullaev, & Annaev, 2007, pp. 30–31, picture 14); (b) – (Choriyev, Shaydullaev, & Annaev, 2007, pp. 31–32, picture 15).

According to archival materials found from Jarkutan memorial, we can make a conclusion that 52 kind of diverse sign-handwritings inscribed on ceramic items were quite enhanced.

It is worth mentioning that some stamps and seals found in Jarkutan memorial were used in agricultural and economic spheres and sectors which means that farming archives also existed in this period of time.



Figure 2. Jarkutan. Pictographic characters (Choriyeu, Shaydullaev & Annaev, 2007, p. 27, picture 10).

Aybuyirkala and Kuykirilganqala handwritings as an archive documents.

Ancient Khorezm is highly regarded as one of the civilized zone in Central Asia and Khorezmian handwriting is directly interconnected with “Avesto”. According to historians, the further development of writing system in Uzbekistan was connected with the recording of “Avesto”. Researchers divided Khorezmian handwriting culture into two chronological stages. The first period scopes the time from IV–III BC to VIII–IX BC. While the second period started from IX–X until XIV BC. The most ancient handwriting example which was written on the surface of a vase was found in Aybuyirkala and it is still considered as an initial Khozermian handwriting sample. M. Mambetullaev was the first scientiest who explored this script and wrote several scientific works related to it (Mambetullayev, 1990, pp. 91–131). Taking into consideration the style of writing and the period the monument belonged to, A. S. Sagdullaev and several archival scientists considered that this script dated back to V–IV BC. Similar samples were also explored in Kuykirilganqala, Kalaikir, Govurkala, Burlikala, Xumbuztepa and Yakkaperson. Such findings prove that handwriting existed in Khorezm in ancient times. The scientists interpreted handwriting in Kuykirilgan, namely “aspabarak” as “a horseman”. The word “horseman” preserved on the surface of the ceramic and it can be perceived as archival information about the famous person of a particular region preserved on household items.

Similar to the scripts found in Oybuyikala and Kuykirilgankala, Aramaic handwriting samples were found in two areas of Central Asia in IV–III BC. One of them is a seal-ring that was found in Amurdarya. The seal-ring has 4 signs, and had a shape of a man-bull, Gipadshoh and there was a script like WHSW, Wahsh, the ancient name of the river Amudarya. Referring to the above mention information we can say that the scripts inscribed on ceramic dishes which were found in ancient memorials of Uzbekistan infer to the notion that there were household archives which were the first samples of economic archives of ancient times. Some people recorded and registered information about the capacity of ceramic items and the products inside of them.

In the time of Ahamanids, Satraps and military leaders were continuously controlled by the king of the kings and by the central government. Governmental management and inspections were carried out by Xazarapad. At the same time, he controlled the personal guardia of the king of the kings.

The management system of Satraps and the composition of the chancellery in many places were exactly similar to the main chancellery in Suza which can be seen in the examples of such duties as chancellery leader, treasurer, braker of rioters, accountants, the judge, scribes and etc. In the literature of Soviet Oriental studies, the idea that Aramaic was made the sole state language and the script of the empire was forwarded. But according to the information of the recent research, Doro I was obliged to accept several languages as a state language. In Asia Minor chancellery works were done in Greek and it was in Aramaic language in Kapadokia, Kilikia, Suria and Palestine. When it comes to Egypt they used hieroglyphics, while in Central Asia and Persia Aramaic & cuneiform handwritings were utilized. One can sum up that in the area of the empire, sole Aramaic language was not seen and used as a chancellery language.

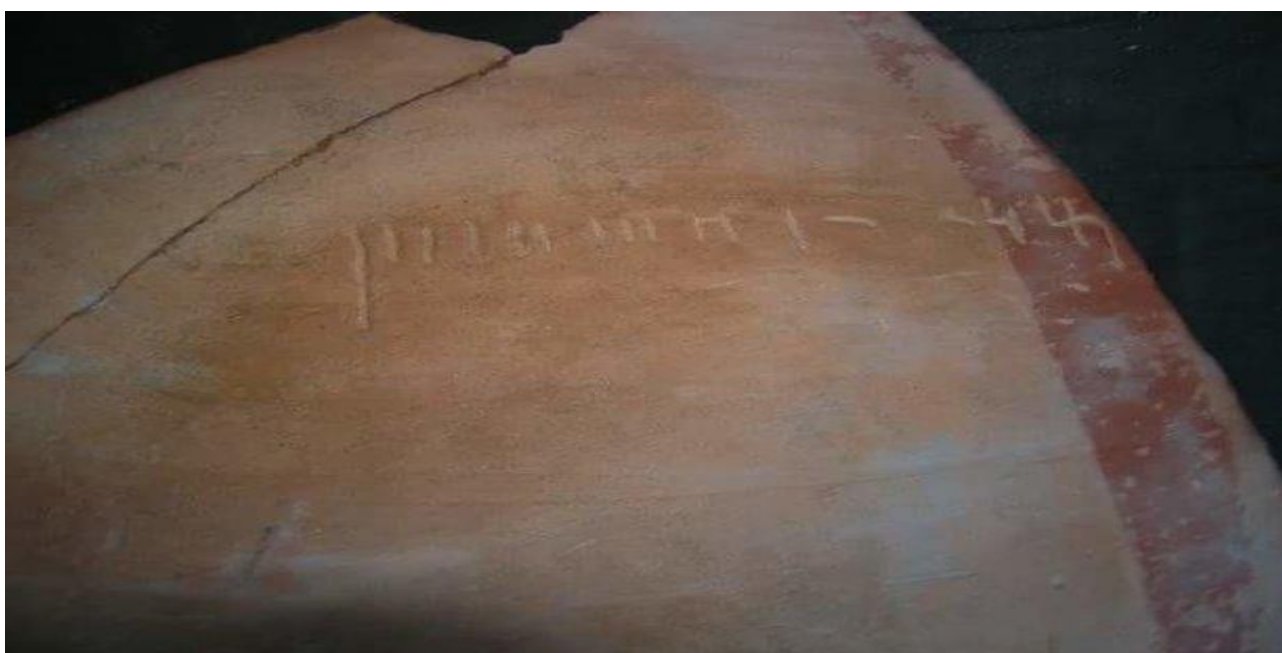


Figure 3. Oybuyirkala handwriting (Ishakov, 2006, p. 33, picture 2).

Document found in the monument Oykhonim.

During the Parthian kingdom, along with the Greek script, the Aramaic script was preserved. Script sample found in Oykhonim city which is similar to the Aramaic handwriting sample dated back and corresponds to the second half of the II BC. Only 3 lines of the text on household sphere reached us today. According to P. Bernar and V. A. Livshich's, this script was written a lot more in the Bactrian language rather than the Aramaic language (Rtveladze, Saidov, & Abdullayev, 2000). Due to its easiness and specifically conservative writing style, Aramaic language continued existing until the Hellenic governing period. We can precisely see the continuation of Bactrian-aramaic script till the first century of our era from sample models of handwritings and texts. We should also note that this script existed in Termez back to Kushans' time.

Sogdian scripts.

The Sogdian handwriting had been of utmost importance until the Arabic caliphate period. This type of script dated back to approximately the I BC and the I AD. In the early middle ages Sogdian script was used in such regions as the old Marv of Eurasia to Altay, Mongolia, China and Tibet (Livshits & Khromov, 1981, pp. 347–515), while the Sogdian language was the first means of understanding and communication in trade. The Sogdian script samples were not only found in Sugd in Central Asia but also in such places like Chach, Fergana and Semirechye. Although there is no any single information about when and where Sogdian script was created. The first samples were found back in the I BC and the I AD, and there were silver coins made in the Bukhara region imitating Evtidem, who was Greek Bactrian and these samples are considered to be the most ancient items of the Sogdian script.

Many samples of the Sugd script have been found in Uzbekistan and out of them distinguishes with its uniqueness a 16-lined vertical script written with an ink on the walls in Afrasiyab relics (1965). The scripture was read by Livshits and it belongs to the second half of the 7th century BC. The context says that the king of Samarqand Avarhuman received the ambassadors of Turontosh, the king of Chaganyan (current Surhandarya) leaded by Pukarzod. They brought maids and presents with themselves (Al'baum, 1975, pp. 52–56). The information about king's official reception of the ambassadors was recorded on the script example from Chaganiyan. A theory has been forwarded that the information about this official reception had been recorded on the wall according to the order of the king.

Specifically, it was the fortress wall that served as a medium for storing this official miniature document. The thing that can serve as an evidence about the existence of archives in that period is archival documents found in the Mug mountains and cliffs. We can conclude that these inscribed documents on the wall were completed to demonstrate the king's political and diplomatic role in his kingdom. Alongside with investigating Sogdian script in Chach in recent years, interesting information and data has been gained. The examples contained coin with the name, date and even the names of the region (Rtveladze, 1997–1998, pp. 307–328). The most ancient coins of Chach dated back to the III–IV AD and most likely at this times local inhabitants knew the Sogd language and scripture.

Archive of Tuprokkala, Khorezm.

The archive of the Khorezmian kings belonging to the third century was found during the expedition of the palace complex located in the ark of Tuprokkala, the capital of ancient Khorezm which served as the king's residence. In 1947–1949, the members of the Khorezm archeological-ethnographic expedition under the leadership of S. P. Tolstov found 140 documents of the ancient Khorezmian people written on leather and wood in the king's archive in Tuprokkala palace. 122 of them were written on the leather and most of them already decayed.

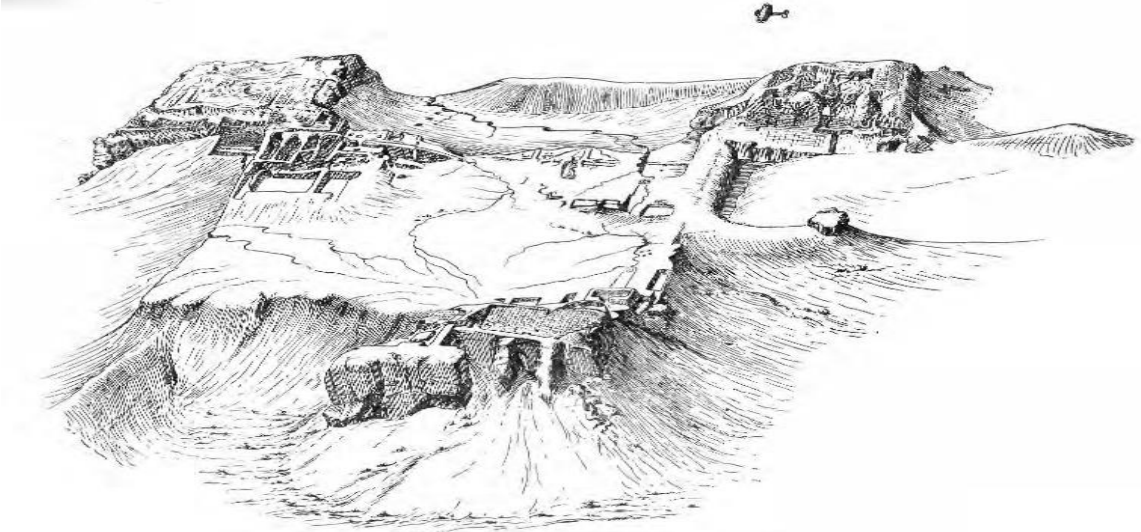


Рис. 45. Пано́рама раскопок Топрак-кала (худ. И. П. Толстов)

a



b

Figure 4. Toprakkala excavations: (a) – panorama of the Toprakkala excavations (Tolstov, 1948, p. 177, picture 45); (b) – an aerial view of the excavations at the governor's palace in Tuprokkala (Tolstov, 1964, p. 183, picture 45).

Only 18 documents written on the leather and 8 wooden documents written on the wood were preserved in a good condition. The most essential part of these documents were related to administrative and economic matters and were written in the Aramaic language type. The language of these documents is similar to the Persian (farsi) language belonging to the XIII–XIV centuries in Khorezm which was verified by A. A. Freyman and other linguists. Also, some documents indicate the year. These dates were written on the leather and they are 207, 231 and 232 which are considered as unknown. The cultural layer where the documents were found belongs to the Kushan-Afrigi period of Khorezm history dating back to the III–IV centuries (Alimov, 2004, pp. 3–5).

Archived documents inscribed in Bactria script.

The Bactrian script which spread over a huge area starting from India to Eastern Turkestan in the early middle ages comes next after the Sogdian script in terms of geography (location) of its distribution in Central Asia. The significance of this language can be seen in the fact that it was used in two great countries as Kushan and Eftalids and later in the state Tokhar.

The suggestion about announcing it as “Bactrian script” was put forward by B. Khen (Rtveladze, Saidov, & Abdullayev, 2000). But Kushan kings themselves declared it as the Aramaic (Aramiy) language. The coins of the first Kushan kings were inscribed in the Greek language, and in the time of “Kanishka” (the first half of the II century AD) the coins had the following script “Shaonano Shao Kanishka Kushan” in the Bactrian language meaning “the king of the kings Kushan”. According to this, the idea that Bactrian script was created in the time of Kanishka came to existence. However, recent findings give a hint that Bactrian script existed even before the era of Kanishka and with the help of several scripts of Dashti Navur, J. Fusman came to a conclusion that alongside with Khoshatkhi and unknown script, Bactrian handwriting also existed. Later in the time of Kanishka, the Bactrian script became the state language.

There are approximately 25 letters in Bactrian handwriting. A lot of scientists are of one opinion that Tokharistan scripts originated from Bactrian script. From chronological side, Bactrian handwriting has been used for almost 800 years (from I–II AD to VII–IX centuries). In 1954–1959 French archeologists pioneered the discovery and studies of the Bactrian script inscribed on limestones found in the complex of the temple on the hill of Surx-Kotal of Boglan region (northern Afganistan) (Livshits, 1974). And the sample found on the hill of Surx-Kotal is considered to be one of the biggest sample of Bactrian script and this 25-lined scripture was inscribed on limestone. 2 more samples were also found in the same area and they were inscribed on the limestone as well. Rabotak is a monumental letter on the stone. According to their structure, these samples of scripts can be compared to a supplication, a hymn, and recorded archives containing the nation’s decrees written on the rock pillar and the archive in Ashurbanipal library.

Ayritam script is also close to famous Surx-Kotal (Northern Afghanistan) as for its meaning and is considered as the first example of monumental inscriptions of this

type for right-bank Bakhtaria. Both scripts are about a construction. Ayritom scripts were carved by so called Mirzod and (...and Mirzod wrote this under the order of Shudya). This handwriting belongs to the beginning or the middle of the II century BC and the text has not been read to the end (Masson & Romodin, 1964, pp. 192–193). This script was written in the Greek alphabet in the style of Kushan and the language in which the inscription was written is an East-Iranian language that is previously unknown to science, and therefore it is complicated to fully comprehend and translate it. This language is a connecting link with Pashtu-pomir languages (munjakh, yigda) and Sogdian, Khorezmian and Partav languages (this language is called Bactrian today). Because of its grammatical structure this language receded away from its ancient appearance as compared to East-Iranian languages.

The following part of the script was read with difficulty: “Khuvishka king, governing years 4, king...gifted (or present) ... became Shudya ... And...he (Shudya) decorated the memorial...Shudya did another thing. He established (in akropol) ... in memorial...(memorial) without water (left), this is why Shudya...dug” (O'zbekiston tarixi, 2013, pp. 159–160).

Based on these half translated historical documents, this can be assumed as the document similar to a report saying that during the reign of Khuvishka, a person named Shudya (Shodya) decorated the pyramid, carried out construction and repair work and provided water to the pyramid.

The translation script in Surkh-Kotal.

“This fortress is named Winner Kanishka memorial, and the king built it for his own memory. Now, at the end of the construction, the water in the pool dried up, as a result the fortress remained without water. When the drought started in the peak heat of summer, Idols were taken away off their nests: The idols were both pictures and statues as well. And the fortress had been empty till the arrival of a noble, hard-working, benevolent, good-doer and well-wishing Nikonzok in the 31st year of his reign. Then he encircled the fortress, dug a well, brought water, and the stone was placed on in the well in such a manner that people inside the fortress would not suffer from water shortages, and when the drought occurred, the idols would not be taken away from their nests in the heat of summer, and the fortress would not become empty. A special device was built above the well to raise the water and also a reservoir was constructed. Due to this well and reservoir the fortress flourished. The well was constructed by subordinates of the king: Hirgoman, Kuzgashka's son Burzmihr, Astilgancig and Nikonzok. And Evman Mihrahan wrote this together with Burzmihr-puhr and Amir Raman”.

According to textural analysis of the above given document the text found in Surkh-Kotal monument was written in the form of a report. In the early middle ages in the area of Central Asia kings inscribed the important achievements of their time in the form of historical reports on solid rocks to preserve them for longer period. It seems that the technology of inscribing information similar to the Behustun script written in the time of Ahamanids also entered the areas of Central Asia.

Archival documents of Mug mountain (or archive of Divashtich).

During the excavations in the castle on Mug mountains 120 km east of Samarkand, archival of sughd documents belonging to the beginning of the 8th century AD showed a big role of sughd language and script in Central Asian people's history and culture. There were found 89 documents in various languages like Sughdian, Arabic and Chinese. 74 of archival documents were written in Sogdian script, and most of them were personal and diplomatic letters, contracts and yearly accountancy records of the economy. A lot of researchers such as A. Freyman, V. Livshits, M. Bogolyubov, O. Smirnov carried out studies on interpreting these archive documents. A large amount of documents were found in Panjikent and in the areas surrounding it, precisely, from Zarafshan upstream. They are connected with the name of Panjikent governor – Divashtich and in a lot of documents the king of Sugd was reminded as Samarkand governor.

In the battle against to Arabs, the notice sent to Divashtich by Fatufar, the representative of Divashtich who was sent to Chach to conclude an agreement with the rulers of Ferghana and the khan of Tires, was of particular interest.

It's interesting to learn the letter sent to Divashtich by his representative Fatufar who was sent to Chach with a special assignment in order to sign a treaty with the governor of Chach, Fergana and Tires for to combat with Arabs.

Let us give opportunity to present one of the translation of Freyman from Sogdian documents:

“The king of Sughd, the governor of Samarkand Divashtich wishes well-being to the leaders of district and shows his respect. Whenever you get my letter send a healing cup of drink to a person who seek in soul and you opt to give it immediately and he will recover from this and it will save him”.

Precious information about socio-economic, military and cultural history of Sugd was tracked in archival documents found in Mug mountains. For example, the documents inform about 4 types of slaves in the continent, important instructions of family rights and participation of Turks in Sughdian urban life an in the authority.

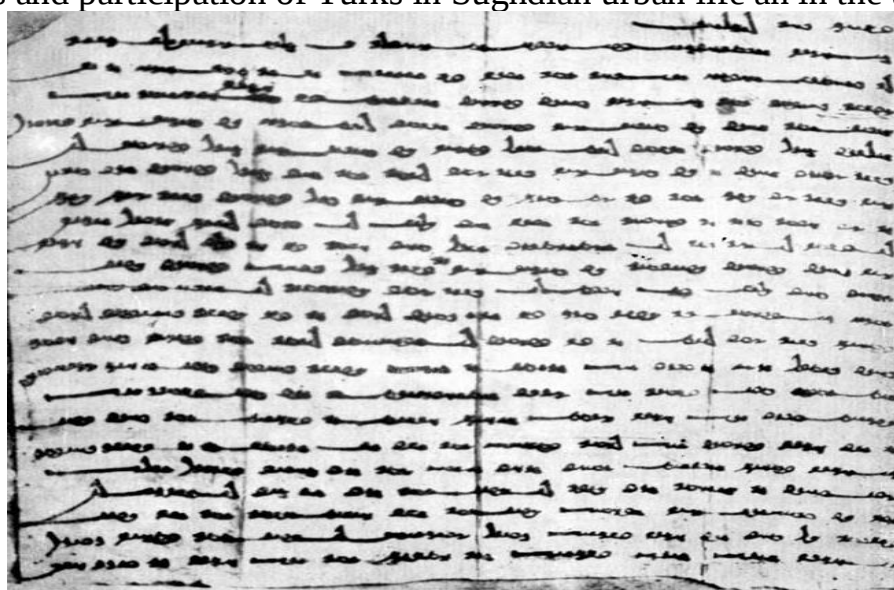


Figure 5. Document 1.I. Archival documents of Devashtish (Livshits, 1962, p. 113, picture 3).

Conclusions.

To sum up, it can be said that the archives of Central Asia and Uzbekistan have a history of many thousands of years and it is proved by wall paintings, stamps and seals, scripts and signs used in the recordkeeping of the households tracked in the settlements of ancient people.

In this area when writing ethics were not developed, people used to deliver messages about their life experiences as hunting methods, religious practices and also household, farm life processes not only via rock paintings, but also with the help of stone, wood, bone, ceramic and later with iron items in order to pass their practical experiences to the next generation. Such rock and cave paintings were preserved in many places of Uzbekistan as Sarmishsoy, Ohangaron and Zarausaroy.

Different types of pictographic scripts discovered in Sopollitepa and Jarkutan monuments refer to the fact that the documents related to the system of recordkeeping and to different institutions of the country were separately stored in the archives. The fact that the seals were utilized for recordkeeping in farming proves the notion that there were archives relating to farming and economy and these archive documents were recorded in pictographic scripts.

The Greek, Chinese, Aramaic, Ancient Bokhtari, Khorezmian and Sogdian languages were key languages used to record important notes and complete particular social tasks until the arrival of the Arabic language in Uzbekistan. In addition, as a result of digging processes a vast amount of documents were discovered and studied.

Referring to the research on the things such as temples, the palace of the kings, defensive constructions, craft facilities, residuals of the settlements and the samples of high civilization and the seals found in Jarkutan memorials belonging to the Bronze age in the area of ancient Bactria, we can conclude that there were various types of archives as urban state archive, the archives of temples and the archives of economy of patriarchal families'.

Satrapes and military leaders were under a constant control of the king of the kings and the central government in Ahamanids' period. There were such professions as the head of the chancellery, a treasurer, accountants, judges, calligraphers and others in Satrapes. It is obvious that the Aramaic language was not a sole language in the whole empire as the office works were also conducted in the Greek language and concerning Kapadokia, Cilicia, Syria and Palestine they utilized the Aramaic language. When it comes to Egypt, they used hieroglyphics dating back to the times of the pharaoh and in Persia and Central Asia Aramaic and the scripture similar to cuneiform were put into practice.

Script samples inscribed on ceramic items which were found in archeological monuments as Kuykirilgankala, Kalaikir, Govurkala, Burlikaala, Khumbuztepa and Yakkaporsan dating back to the III–I centuries BC prove the existence and development of economic archives in the form of scripture in the territory of Khorezm after the era of Ahamanids.

There were special palace archives of Khorezmian kings in the king's residence (belonging to the III century) on the arch of Tuprakkala, the capital of ancient Khorezm.

The library archives were also developing in the religious temples in the I–II centuries AD.

In the regions of Central Asia, in ancient times, city state archives, personal archives of patriarchal families and economic archives existed, and later archival libraries began to appear in temples. Basically, documents were recorded on ceramic items and limestone slabs.

Archives of the palaces started to operate systematically in the early Middle ages. Leather and wood were widely used as a tool of recording archival information. Different types of documents as diplomatic and private letters, agreements and economical notes were stored in the archive. Additionally, recordkeeping in state institutions was improved at that period of time.

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Conflicts of interest.

The authors declare no conflict of interest.

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Історія архівів Середньої Азії: стародавні часи

Анотація. У цій статті досліджено історію архівів Середньої Азії на основі археологічних досліджень, проведених протягом останніх десятиліть. До цього часу практично не проводилися комплексні дослідження з вивчення середньоазіатських архівів давнього періоду. У цій статті висунута і обґрунтована, на основі конкретних фактів, ідея про досвід давніх людей, які проживали на території сучасного Узбекистану, в галузі зберігання документів та передачі інформації з покоління в покоління, включаючи наскельні зображення та документи архівів-бібліотек. На основі наукових досліджень вчених можна зробити висновок, що елементи писемності, виявлені на керамічних виробах давності, можуть служити зразками ранніх господарських архівів на території Узбекистану. У період Ахеменідів в Ірані та Середній Азії було поширене клинописання, і на території всієї імперії арамейська писемність не використовувалась як єдина мова діловодства. Як зазначено в статті, за географією поширення бактрійська мова займала друге місце після согдійської мови і була широко поширена на території від Індії до Східного Туркестану. Той факт, що дві великі імперії – Кушан і Ефталітів, а потім і держава Тахіридів використовували цю писемність, свідчить про важливе значення бактрійського давнього письма в житті древніх народів. У цій статті наведені схожі риси бактрійського письма, що використовувалося при складанні договорів Сурх-Котал, Рабатат, зразками письма в документах бібліотеки Аишурбаніпала та хеттського письма, яким були вирізані тексти гімнів, рішень народного збору,

релігійних фрагментів на камені. Поряд з цим у роботі наведено відомості, що підтверджують існування спеціальних архівів у резиденціях давніх правителів Середньої Азії – у Топраккале (Хорезм) та Мугській горі (архів Девашича). Зокрема, у архівах правителів було систематизовано архівну роботу, а для фіксації інформації в архівних документах широко використовувалися матеріали, такі як шкіра та дерево. У цей період у архівах зберігалися особисті листи та дипломатична переписка, договори, господарські облікові записи. Також слід відзначити, що у цю епоху була значно удосконалена система діловодства в державних установах.

Ключові слова: Сапаллімена; Джаркутан; піктографія; Стародавній Хорезм; Согдійська мова; архів Девашича

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Metal ornaments from the burial mound necropolis Chornyanka of the Bilozerka culture (11th–10th centuries BC)

Abstract. *The flat cemetery near the village of Chornyanka, Kakhovka district, Kherson region, is one of the largest row grave fields of the Late Bronze Age archaeological culture of Bilozerka in the northern Black Sea region. The cultural and chronological location of the Chornyanka burial ground was determined on the basis of an analysis of the main features of the funerary constructions, ceremonies and equipment. The established date of its functioning is the 11th–10th century BC. 24 graves were identified and investigated. Most contained grave goods: pottery, bone and bronze tools, jewellery of bronze, bone, agate, mother-of-pearl, chitin and glass. This paper presents the results of metallographic and X-ray spectral analysis of bronze jewellery from Chornyanka cemetery: pins, temple rings and earrings. It presents and describes the characteristic microstructures of the metal finds. In addition, the process of production of various metal objects was investigated. Several chemical and metallurgical groups stand out in the spectral analyses of metals from Chornianka: Cu-Sn; Cu-Sn-As; Cu-As(Sn) and possibly remelting. Correlation diagrams of the characteristic pairs of elements are also given. In all the analyses, arsenic is present in tenths of a per cent. There is also a stable presence of an impurity such as antimony, mostly in tenths of a per cent, with concentrations in two cases reaching whole per cent. This means that they were probably included in the original ores. Some scientists believe that this feature is characteristic of the metallurgy of the Greater Caucasus. The results are compared with similar analyses from another cemetery of the Bilozerka Culture – Shyroke. Despite the general similarity and tradition, it is possible to highlight some differences in metalworking in both Bilozerka cemeteries (Chornyanka and Shyroke). Jewellery was made not only by casting. It was also forged with the help of mandrels. In addition, some products were made by welding several metal strips. Most researchers pay attention to the influence of the cultures of the Northwest region on the Bilozerka culture. Metalworking is traditionally thought of as having a Volga-Urals orientation. In this article, we propose to take into account new data on the chemical composition of metal and technology, which testify to the contacts of the Bilozerka culture with the Caucasus.*



Keywords: *Late Bronze Age; Bilozerka culture; bronze jewellery; metallographic analysis; X-ray fluorescence analysis*

Introduction.

The Kherson archaeological expedition investigated the Bilozerka culture burial ground in 1979. It was located near the village of Chornyanka, Kakhovsky district, Kherson region, on the plateau above the left slope of the “Black Dolyna” tract. The burials were arranged in a northwest–southeast chain with a slight shift in the middle. A total of 24 burials were identified and examined (Kubyshev & Chernyakov, 1986, p. 140, fig. 1).

Nowadays, the scientific community knows the Bilozerka culture burial grounds, which are concentrated along the Dnipro and between the Bug and Prut rivers (Kubyshev & Chernyakov, 1986, p. 155, fig. 9). Among them, Shyroke is the flat cemetery with the largest number of burials, studied in 1975 and only recently published in detail (Leskov, Kravchenko, & Hoshko, 2019). Chornyanka is the second largest cemetery after Shyroke.

Artefacts of material culture, represented by ceramics, tools, clay moulds, weapons and jewellery of the Bilozerka culture, have been studied by many archaeologists. The vast majority of works were devoted to chronology, funerary rites, and the typology of ceramics and metalwork. The chemical composition of the metal of the Bilozerka culture was studied by E. M. Chernykh (1976, pp. 48–50). His main conclusion was that the eastern centres – the Urals or the Volga-Urals – played a leading role in the development of Bilozerka metalworking. Later, similar studies were conducted only by the author of this article (Horbenko & Hoshko, 2010, pp. 97–111; Hoshko, 2019a; Hoshko, 2019b). It is assumed that the metal came to the Right bank of the Dnipro (to the fortified settlement of Dykyi Sad, located in Mykolaiv, at the confluence of the Pivdennyi Buh and Ingul rivers) from the Carpathian mining and metallurgical centres. In contrast, on the left bank of the Dnipro (Shyroke flat cemetery cemetery), the metal is of Caucasian origin.

There is a small number of studies on the technology of manufacturing Bilozerka metal products using metallographic analysis. This includes only the author's work mentioned above.

The metal products of the Bilozerka culture on the left bank of the Lower Dnipro are not distinguished by their variety. They are mainly ornaments and a small number of tools. The technological and X-ray analysis of the materials of the Shyroke became the beginning of their study (Hoshko, 2019b). This article is a logical continuation of the research on the Bilozerka metal.

Methods.

Metal products from Chornyanka are presented in a small collection – only 23 items. Most of them are ornaments: pins, wire temple rings (earrings?), tube beads and spirals (Fig. 1–2). Unfortunately, the metal is damaged by corrosion. It is sometimes impossible to determine the shape or thickness of the product. A small awl is the only tool found in the burials.

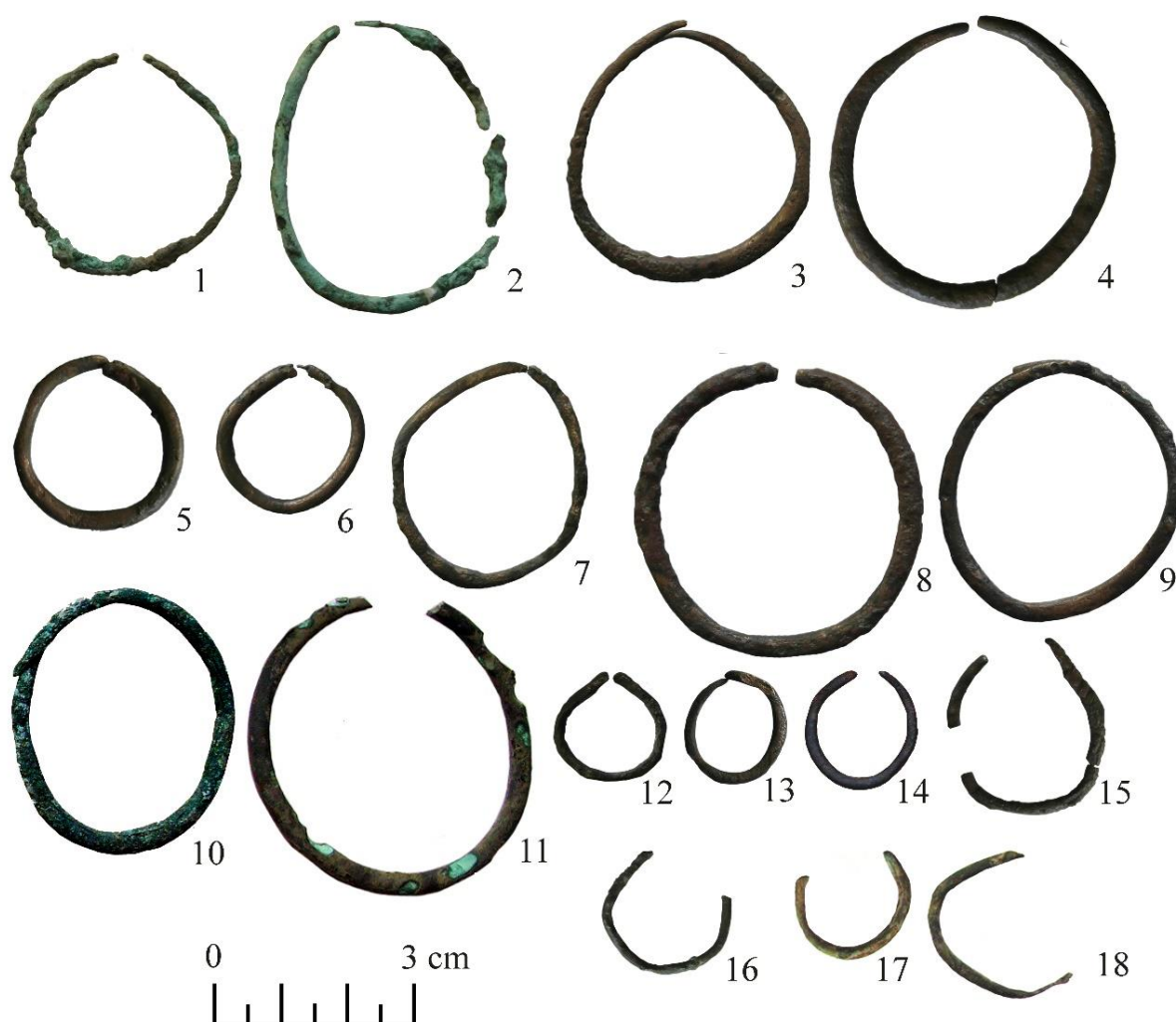


Figure 1. Metal products from Chornianka. The slant indicates metallographic/X-ray fluorescence analysis. 1–2 – grave 1; 3 – grave 2 (lab. No. 261/120); 4 – grave 2 (lab. No. –/1002); 5 – grave 13 (lab. No. 262/121); 6 – grave 13 (lab. No. 263/122); 7 – grave 16 (lab. No. 264/123); 8 – grave 19 (lab. No. 265/124); 9 – grave 19 (lab. No. 266/125); 10 – grave 20; 11 – grave 20 (lab. No. 267/126); 12 – grave 20 (lab. No. 268/127); 13 – grave 20 (lab. No. 269/128); 14 – grave 20 (lab. No. –/997); 15 – grave 20 (lab. No. –/1004); 16 – grave 20 (lab. No. –/1005); 17 – grave 24 (lab. No. 70/129); 18 – grave 24 (lab. No. 271/130).

Temporal rings, regardless of their size, were placed on the skull or under the skull close to the auditory canal. There is no doubt that rings of small diameter are earrings. They have either one pointed end or both are blunt.

Table 1 shows the parameters of these ornaments: diameter, wire thickness and others. In general, they can be divided into three groups. The first group consists of five large rings with a diameter of 40–44 mm, made of wire 2–4 mm thick, round or rectangular in cross-section. Both ends of the wire are pointed (2 rings), or only one (2 rings), or both are blunt (1 ring).

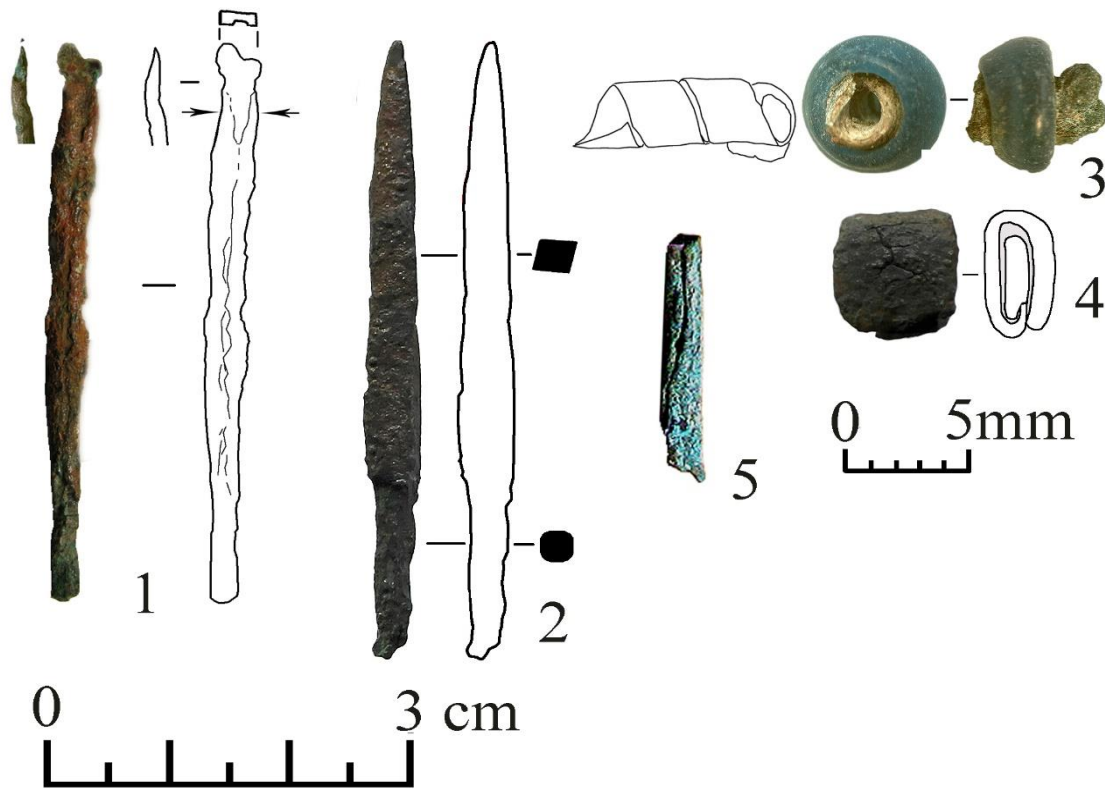


Figure 2. Metal products from Chornianka: 1 – pin, grave 5 (lab. No. 272/392); 2 – awl, grave 12 (lab. No. – /1003); 3 – spiral, grave 9; 4 – piercing, grave 9; 5 – piercing, grave 19.

Table 1. Parameters of temple rings and earrings from Chornyanka.

No. burial	X-ray fluorescence analysis	metallographic analysis	Diameter mm	Wire		Wire ends			
				Thickness mm	Cross-section	Pointed		Both blunted	Both narrowed
1	—	—	37×44	2	○		●		●
1	—	—	38.5	3	○		●		●
2	120	261	37×40	3.5×2	▨		●		●
2	1002	—	26	4	○			●	●
13	121	263	23	3×2	▨			●	●
13	122	262	27	3	○			●	●
16	123	264	30×40	~2	▨	●			●
19	124	265	42	3	○			●	
19	125	266	36×38	3.5×2	▨	●			●
20	—	—	32×38	3	○	●			
20	126	267	44	3.3	○	●			
20	127	268	16.8×16	2	○			●	
20	128	269	16	2	○	●			
20	997	—	*	2	○	*	*	*	*
20	1004	—	*	1.5	○	*	*	*	*
20	1005	—	~18	~2	○	●			
24	129	270	16	2	○	●?			*
24	130	271	*	2	○	*	*	*	*

Comments: ○ – round wire cross-section; ▨ – flattened wire cross-section; * – not restored.

Table 2. Results of X-ray fluorescence analysis of products from Chornyanka.

No. analysis	Grave	Product	Sn	Pb	Zn	Bi	Ag	Sb	As	Fe	Ni	Co	Au
120	2	ring	5.542	0.129	—	—	0.188	0.667	0.222	0.053	0.018	—	—
122	13	ring	1.159	0.128	—	—	0.246	0.761	0.328	—	0.031	—	0.135
124	19	ring	2.328	0.171	0.305	—	0.114	0.551	0.372	0.054	0.123	—	—
127	20	ring	8.242	0.2	—	—	0.106	0.239	0.307	traces	0.266	—	—
392	5	pin	1.482	0.2	—	—	0.5	1.033	0.479	traces	0.467	—	—
1004	20	ring	11.563	0.222	0.118	—	0.037	0.094	0.162	0.07	—	<0.029	—
1005	20	ring	8.806	0.585	0.309	—	0.142	0.54	0.366	0.121	0.072	<0.04	—
126	20/1	ring	1.32	0.014	—	0.006	0.066	0.155	1.081	—	0.025	—	0.073
997	20/1	ring	1.066	—	0.044	0.027	0.1	0.171	1.516	traces	0.179	—	—
123	16	ring	1.548	0.06	0.191	—	0.161	0.262	0.759	<0.013	0.313	—	0.088
125	19	ring	2.033	0.038	—	—	0.093	0.141	0.691	0.024	0.016	—	0.092
129	24	ring	2.781	0.033	—	0.009	0.128	0.309	0.898	<0.046	<0.051	0.071	0.044
128	20	ring	0.238	0.021	—	—	0.05	—	1.463	0.063	0.009	—	0.09
1003	12	awl	0.07	—	0.216	—	0.04	0.036	1.264	<0.046	<0.051	0.071	0.044
1002	2	ring	0.674	0.115	—	0.015	0.298	0.633	0.848	0.059	0.086	<0.048	—
121	13	ring	0.872	0.183	—	—	0.286	0.872	0.446	—	0.447	—	0.126
130	24	ring	0.41	0.158	2.113	—	0.644	1.366	0.268	0.022	0.108	—	—

The second consists of three rings of medium size – 30–38 mm in diameter – made from wire of the same thickness as the large rings (3–4 mm). In one case the wire is flattened in the center, the others have a round cross section. A pointed end of the wire in 2 rings; one has both blunted.

Small rings, probably earrings, with a diameter of 16 to 27 mm (7 specimens) are part of this group. The thickness of the wire varies from 1.5 to 4 mm, one of them is flattened in the middle. Four ends are blunt. Three ends are pointed.

Temple rings and earrings are mainly women's and children's jewelry. Men's clothing also shows similar decoration. However, it is much rarer. Temple rings and earrings were found in only one burial, No. 2 at Chornyanka¹. In another ground necropolis of the Bilozerkha culture, Shyrokye, the same ornaments are more frequently found in the accompanying inventory of male burials. Temple rings and an earring were found in burials 30, 40 and 107 (Kravchenko, 2019, pp. 48, 57, 118). It should be noted that the skeleton of a man² from burial 107 was lying on his left side and had, in addition to two temple rings, a pin with a looped head (Kravchenko, 2019, p. 118, fig. 1.118, 2).

Results and discussion.

Spectro-analytical (17) and technological (12) studies of the products from Chornyanka have been carried out. Technological details of production were revealed in the process of visual surface examination of objects with the help of binocular microscope MBS-200. The metallographic analysis was carried out with a MIM-7 microscope, and a PMT-3M micro-hardness tester was used to measure micro-hardness. The surfaces of the products cleaned of oxides were subjected to metallographic and X-ray fluorescence analyses.

¹ As concluded by anthropologist S. I. Kruts (Kubyshev & Chernyakov, 1986, p. 145).

² Zinevych & Kruts, 1968, p. 61, tab. 9.

*X-ray fluorescence analysis*³.

The determination of cobalt (Co) and bismuth (Bi) by this spectrometer makes it impossible to include these two elements in the analysis. As shown in Table 2, small concentrations of cobalt and bismuth in the metal are sometimes indicated in the analyses. The X-ray fluorescence results in the table are grouped by selected compositions.

Several chemical and metallurgical groups have been identified in the metal samples from Chornyanka: Cu-Sn; Cu-Sn-As; Cu-As(Sn) and possibly remelting.

The first Cu-Sn group contains 7 analyses – lab. No. 120, 122, 124, 127, 392, 1004, 1005. Their stannic content ranges from 1.159 to 11.563%. It is noteworthy that in all analyses arsenic is present in quite noticeable concentrations (from 0.162 to 0.479%). There is no doubt that a tin ligature was used here.

The second group, Cu-Sn-As, can be considered as a double tin-arsenic alloy. It includes five analyses – lab. No. 123, 125, 126, 129 and 997.

The content of tin in the metal composition is lower: from 1.066 to 2.781%, and the concentration of arsenic slightly increases in comparison with the previous group (from 0.759 to 1.516%).

Three analyses are included in the group of arsenic bronzes Cu-As(Sn): lab. No 128, 1003 and 1002. As in the previous group, the analyses of the third group contain a rather significant percentage of arsenic (As – 0.848–1.463%).

The appearance of such low percentages of tin in the analyses of this group can be explained either by its transition into metal from copper ore or by the use of remelted products.

A similar metal with a reduced tin content (from 0.1 to 0.8%), known from the Caucasus in the Late Bronze Age, is called "conditionally tin bronze" by S. M. Korenevskyi (Korenevskyi, 1981, p. 148).

It is probable that the metal of the two temporal rings (lab. No 121 and 130) also belongs to the bronzes mentioned above. Alternatively, it may be a re-melted alloy, given the low content of both tin and arsenic.

It is noteworthy that in all analyses arsenic is present in tenths of a percent, as well as the stable presence of antimony, mostly in tenths of a percent, with concentrations reaching whole percent in two cases (lab. No 130 and 392). These minerals were probably part of the original ores. According to S. M. Korenevskyi, this feature is typical for the metallurgy of the Greater Caucasus (Korenevskyi, 1981, p. 153).

The study of the Shyroke metal suggested that it was smelted from Caucasian ores (Hoshko, 2019b, pp. 165, 172). Based on the correlation graphs of metal element pairs

³ The analyzes were carried out at the Institute of Archeology of the National Academy of Sciences of Ukraine on the X-ray fluorescence spectrometer CEP-01 AAES.412131.001, modification "ElvaXLight" with an extended range towards light elements. Registration of fluorescent radiation from the studied sample was carried out using a semiconductor Si-Pin detector manufactured by Amptek (USA) with thermoelectric cooling. The following operating modes of the X-ray tube (MOXTEK, anode material Pd) were set: voltage 45 kV, anode current within 0–100 µA. Registration of normal spectra at an emitter voltage of 40–49 kV and light spectra at a voltage of 10–15 kV.

The modification of the spectrometer "ElvaX Light" is equipped with a helium injection system into the working chamber. The standard spectrum acquisition time is 100 s. The sensitivity threshold of the spectrometer for tin (Sn) and nickel (Ni) – 0.05%, zinc (Zn) – 0.1%, lead (Pb) – 0.02%, silver (Ag) – 0.01%, 0.05%, antimony (Sb) – 0.01%, bismuth (Bi) – 0.008%, and cobalt (Co) – 0.08%.

from the Chornyanka and Shyroke cemeteries, we can claim a great similarity (Fig. 3). It is particularly noticeable in the graphs of Sb–Ag and Sb–Pb.

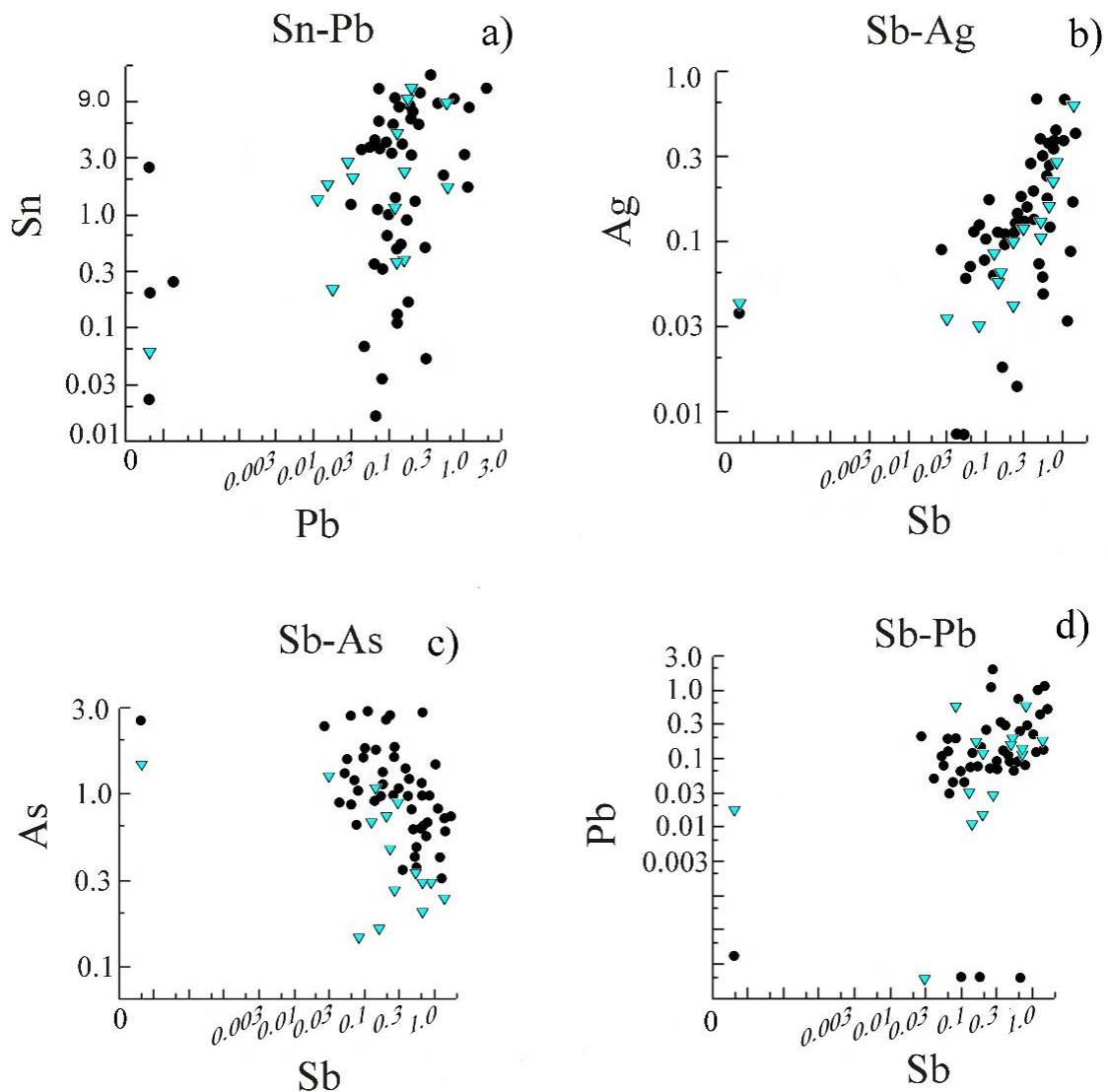


Figure 3. Correlation plots of copper impurities from Chornyanka and Shyroke cemeteries: a) Sn–Pb; b) Sb–Ag; c) Sb–As; d) Sb–Pb. Symbols and notation: $\triangle$ – Chornyanka; $\bullet$ – Shyroke.

So there is reason to believe that the masters of the Bilozerka culture imported metal from the Greater Caucasus. However, we can only talk about the population living in the lower reaches of the Dnipro.

E. A. Kravchenko also does not exclude a possible connection with the Caucasus (Kravchenko, 2019, p. 160). She draws attention to the similarity of the burial rites of the Bilozerka and Koban cultures and to the conclusions of anthropologists on the morphological similarity with some series of skulls from the Caucasus – from the Samtavro cemetery (second variant) (Zinevych & Kruts, 1968, p. 89).

Technological study.

A total of 12 items were subjected to metallographic examination: 11 temple rings and one pin (Fig. 4, Fig. 5).

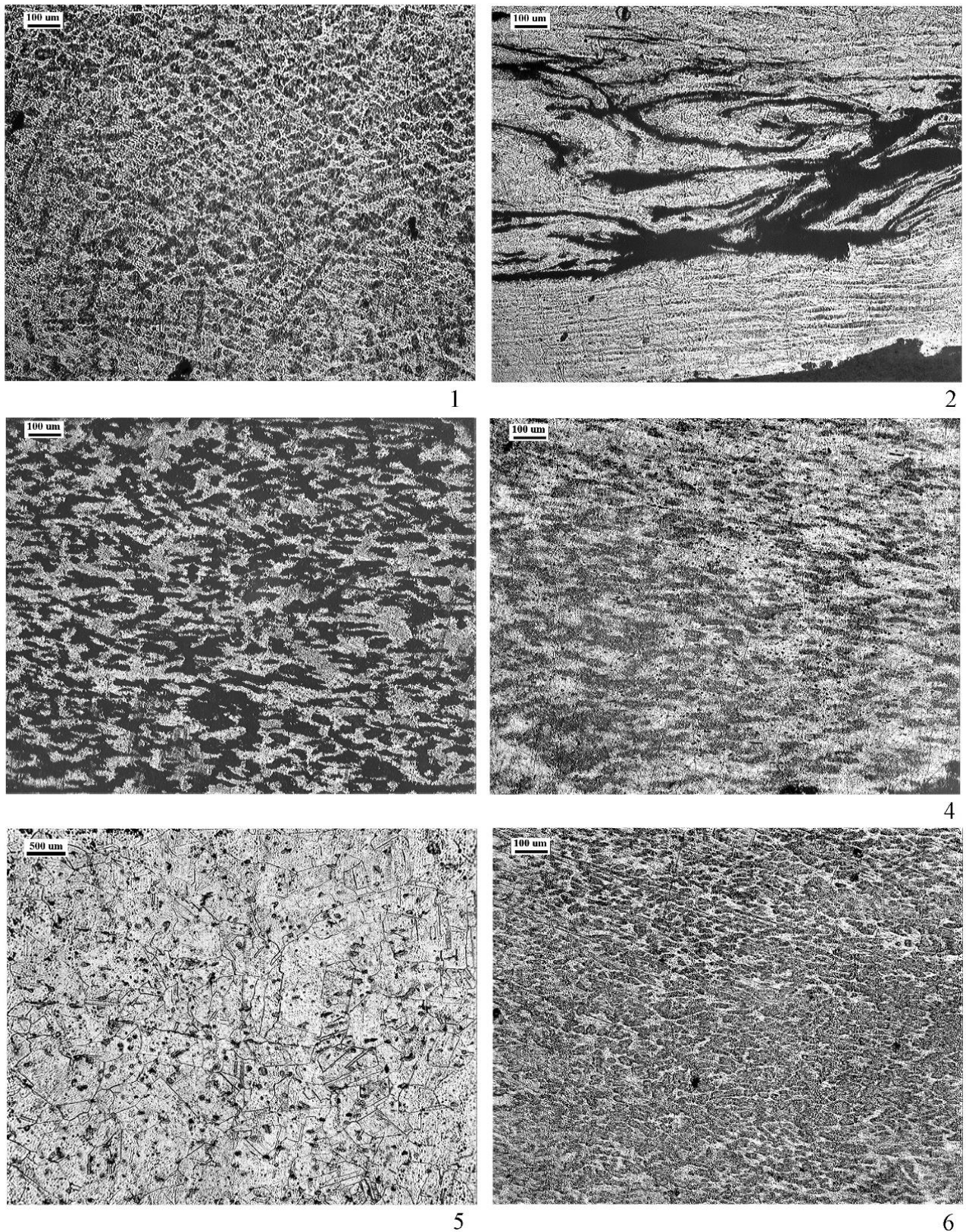


Figure 4. Microstructures: 1 – lab. No. 261; 2 – lab. No. 262; 3 – lab. No. 263; 4 – lab. No. 264; 5 – lab. No. 265; 6 – lab. No. 266.

There is not enough information on the effect of forging at different temperatures on copper with arsenic content up to 1%, despite an interesting and necessary work by Ravich and Ryndina (Ravich & Ryndina, 1999, pp. 77–98). Arsenic bronze castings have a dendritic structure. It was found that dendritic liquation in copper-arsenic alloys is more stable than in tin bronzes. It is preserved after high degrees of compression and after annealing. Therefore, it can only be stated that the temperature regime of the forging billets was in the range of the onset of recrystallisation (350°C) and in the range of the final recrystallisation (400–700°C).

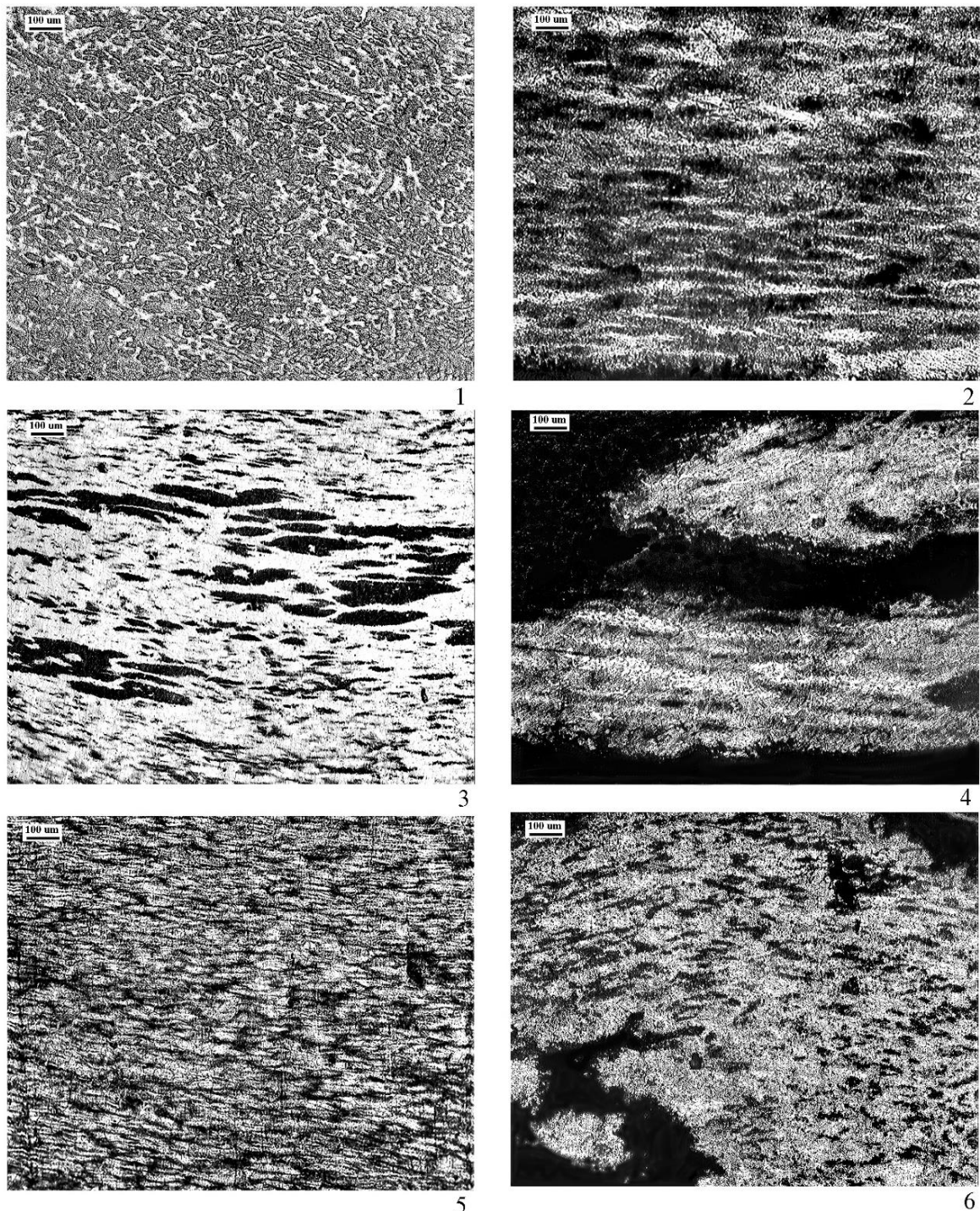


Figure 5. Microstructures: 1 – lab. No. 267; 2 – lab. No. 268; 3 – lab. No. 269; 4 – lab. No. 270; 5 – lab. No. 271; 6 – lab. No. 272.

The technological scheme for the production of wire products was as follows. The wire was made from a cast billet forged on a special anvil with a chute. It is impossible to determine whether the forging was carried out in cold metal with annealing or in a hot state. However, given the residual more or less deformed microstructure of the castings, the billets were mainly heated to an incandescent temperature of 500°C. The workpiece was then cut into the required lengths, sometimes with one or both ends sharpened. Sometimes both ends were left blunt. Finally, the rings themselves were formed. Sometimes the bent ring was additionally flattened on the sides (lab. No. 261/120, 263/121, 264/123, 266/125).

I feel it is necessary to remind you that the metallographic analyses were carried out on whole objects and the location of the grinding was in the central part of the ring. Therefore, the information about the forging temperature and the degree of crimping applies only to the central part of the rings. Accordingly, the deformation was undoubtedly more intense at the pointed ends.

Two pieces of jewellery are interesting from a technological point of view: an earring from grave 13 (lab. No. 262/121) with round wire cross-section and blunt converging ends and a large temporal ring from grave 19 (lab. No. 265/124) made of round wire with converging blunt ends (Fig. 1.5, Fig. 1.8).

Microstructural analysis revealed the presence of a blacksmith's seam on both. There is a branching weld on the earring and a barely noticeable weld on the temporal ring (Fig. 4.2, Fig. 4.5). The microstructure of the earring is a deformation texture with small recrystallised grains with twins on a background of smooth elongated dendrites by forging. The grain size is 0.025 mm. Microhardness 98.6 kg/mm². Despite the fact that a fairly high degree of deformation has been applied, welding has been unsuccessful, although the seam is not visible from the outside.

However, the welding of the temporal ring was successful – the seam is almost invisible. The strain was higher because the cast structure is more deformed and the percentage of recrystallised structure is higher than in previous analyses. The grain size with twins is 0.035 mm. Microhardness 134.6 kg/mm².

The next few temporal rings from burials 2, 19, 20 (lab. No. 261/120; 266/125; 267/126) are less forged (Fig. 4.1, Fig. 4.6, Fig. 5.1). Two of them are flattened in the middle and the third has a round cross section (Table 1). The cast microstructure is slightly disturbed by forging, with a low degree of compression – about 20%. Microhardness 127.6 kg/mm² (261/120); 112.7 kg/mm² (266/125); 132.2 kg/mm² (267/126). No recrystallised grains were observed. It is likely that the microstructures acquired this appearance as a result of a single heating to 400–500°C, which may be due to their bending into a ring.

As for the other five earrings (lab. No. 263/122; 268/127; 269/128; 270/129; 271/130) and the temple ring (lab. No. 264/123), the technology of their manufacture differs little from that of the previous three, except for a greater degree of deformation by 20–40%. This is reflected in the microstructures with smaller polyhedral grains against a background of dendrites deformed by forging (Fig. 4.3; Fig. 5.2–5). Microhardness 108 kg/mm² (lab. No. 263/122); 133.6 kg/mm² (lab. No. 264/123);

146 kg/mm² (lab. No. 268/128); 108.4 kg/mm² (lab. No. 269/128); 108.4 kg/mm² (lab. No. 270/129); 110 kg/mm² (lab. No. 271/130).

All that remains of the pin is a fragment of the rod with the remains of the head (lab. No. 272/392). The pin was made by free forging from a rectangular billet (the outer seam formed during forging is visible along its entire length) forged to a circular cross section (Fig. 2.1). The head was made from the riveted end of a rod rolled into a loop. Forging was carried out at low temperatures with annealing. The microstructure is residual dendritic against a background of small recrystallised grains with twins (Fig. 5.6).

Comparing the technologies of jewellery production at Chornianka and Shyroke cemeteries, we see that in both cases metalworking schemes were used to make temple rings and earrings, which involved casting blanks and then forming them on a fluted anvil with a shaped lining. This explains the uniform thickness and round cross-section of the wire on many products.

Forging at both sites took place mainly at low temperatures of 400–500°C, sometimes rising to 600–700°C at Shyroke. It is possible that the blacksmiths were aware of the high volatility of arsenic vapours, which is why they preferred to heat the metal to low temperatures.

The degree of metal crimping in Chornyanka was low, mostly 20–40%. At the same time, in Shyroke, craftsmen more often chose a higher degree of crimping – 60–80%, less often – 20–40%, and sometimes 100%.

Blacksmith welding can be traced in both collections. There are two cases in Chornianka and one in Shyroke. Most of the temporal pendants from Shyroke are noticeably flattened on both sides. There are only four in Chornianka. Two pins with looped heads from both sites were made by free forging. The rods still have surface seams on them, which were formed when the billets were forged from square sections.

There is no point in comparing the results of technological analysis from the settlement of the Bilozerka culture Dykyi Sad. That collection is more diverse, and the jewellery is represented by a different category – bracelets and hairpins (Horbenko & Hoshko, fig. 1). This explains the variety of technological schemes of metalworking. In general, it is associated with the forging of cast billets at temperatures not exceeding 600°C.

Conclusions.

The nearest to Chornianka in terms of location is the Shyroke necropolis. Therefore, it is best to compare the technology of making metal jewellery from these two sights. There are both similarities and differences between the two collections: 1) the same schemes of metalworking of wire decorations were used; 2) forging at both sights took place mainly at low temperatures of 400–500°C; 3) the degree of crimping of the Chornianka metal was low, mostly 20–40%. At the same time, in the Shyroke collection, craftsmen more often chose a higher degree of crimping of the workpieces – 60–80%, less often – 20–40%, and sometimes 100%; 4) in both collections, forging welding can be traced. The previously expressed opinion about the possible Caucasian

origin of the metal in the Shyroke necropolis is now confirmed by the analysis of metal from Chornianka.

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Conflicts of interest.

The author declare no conflict of interest.

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Металеві прикраси з курганного некрополя білозерської культури Чорнянка (11–10 ст. до н. е.)

Анотація. Рівнинний могильник біля села Чорнянка Каховського району Херсонської області є одним з найбільших ґрунтових могильників Білозерської археологічної культури доби пізньої бронзи у Північному Причорномор'ї. Культурно-хронологічне місце могильника Чорнянка було визначено на основі аналізу основних особливостей поховальних конструкцій, обряду та інвентарю. Встановлена дата його функціонування – 11–10 ст. до н. е. Виявлено та досліджено 24 поховання. Більшість з них містили поховальний інвентар: кераміку, кістяні та бронзові знаряддя праці, прикраси з бронзи, кістки, агату, перламутру, хітину та скла. У статті представлено результати металографічного та рентгеноспектрального аналізу бронзових прикрас з могильника Чорнянка: шпильок, скроневих кілець та сережок. Представлено та описано характерні мікроструктури металевих знахідок. Крім того, досліджено процес виробництва різних металевих предметів. У спектральному аналізі металів з Чорнянки виділено кілька хіміко-металургійних груп: Cu-Sn; Cu-Sn-As; Cu-As(Sn) і, можливо, переплав. Також наведено кореляційні діаграми характерних пар елементів. У всіх аналізах арсен присутній у десятих частках відсотка. Також стабільно присутня така домішка, як сурма, переважно в десятих частках відсотка, причому в двох випадках її концентрація сягає цілих відсотків. Це означає, що вони, ймовірно, входили до складу вихідних руд. Деякі вчені вважають, що ця особливість характерна для металургії Великого Кавказу. Результати порівнюються з аналогічними аналізами з іншого могильника Білозерської культури – Широке. Незважаючи на загальну схожість і традиції, виділяються деякі відмінності в металообробці на обох білозерських могильниках (Чорнянка та Широке). Прикраси виготовлялися не тільки методом лиття. Його також кували за допомогою оправки. Крім того, деякі вироби виготовлялися шляхом зварювання кількох металевих смуг. Більшість дослідників звертають увагу на вплив культур Північно-Західного регіону на Білозерську культуру. Про металообробку існує традиційна уява її волго-уральської орієнтації. У даній статті пропонується взяти до уваги нові дані вивчення хімічного складу металу і технології, які свідчать також і про контакти білозерської культури з Кавказом.

Ключові слова: доба пізньої бронзи; Білозерська культура; бронзові прикраси; металографічний аналіз; рентгенофлуоресцентний аналіз

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Confucius's views on administration and communication

Abstract. *This article analyzes the formation of theoretical views on the nature, methods, and practice of the administrative and communication activities of public authorities in relation to the people of the state in the VI–V centuries BC in Ancient China. Communication ideas are identified, first of all, on the basis of analysis of Confucius' Lun Yu treatise. The adopted method of study here is a systemic approach and comparative historical analysis, allowing us to identify the elements associated with the views of the thinker and determine their significance in the history of the theory of administration and communication in Chinese documents. It shows the conditions of the political and economic life of Ancient China at that time, which promoted the emergence of the philosophical Confucian concepts of public administration and communication. It establishes the sequence and distinctive feature of the humanistic and moral, and ethical views of Confucius on the functioning of the communication models of a state, which are still relevant for the development of science and practice. The focus of the work is on the analysis of specific judgments of the thinker about the structure of communication in the administrative environment. It reveals the communicative content of the key elements of the cornerstone concept of his teachings – Tao. The work considers the reasons for the propaganda of closed government and dosed information flows in the administrative field and in the communication of public officials with the masses. It analyzes the means proposed to make people (subjects) make proper decisions for the authorities in power. This task is still actively discussed in modern communication science. It also interprets some of Confucius' statements that determine the moral and ethical framework of administrative communication and reveals the meaning of his communication model. It identifies the features of that ideal fragmented communication model as a sample limited for practical use by numerous objective conditions. It also specifies the time frame of the “Axial Age” in China's history. And finally, it makes conclusions about the role and significance of Confucius's views in the formation and development of the methods and ethics of communicative action in public administration in the historical and perspective aspects.*



Keywords: *public administration; communication; people; Ancient China; ethics of communicative action*

Introduction.

At present, there is a constructive scientific discourse on the historical priorities and real primary sources concerning the essence, nature, and form of their realization in administrative and communication activities. The controversy is conducted on the issues of the essence of the forms and ethics of communicative state activity, proposed by the philosophers of the past. The practice of propaganda concepts and embodying their ideas continued in the course of the further development of philosophical views and ideas about the management of social processes. The concepts of political culture and ethics of communication were originally investigated by such thinkers as Confucius, Plato, Aristotle, al-Farabi and a number of others, who formed the basis of political science. In historico-scientific terms, this situation remains significant for the productive creation of new effective theoretical models, rooted in the distant past.

According to the German philosopher Karl Jaspers, the foundations of the modern civilizational structure were laid down between the VIII and II centuries BC. (Jaspers, 2017, p. 35). In the history of mankind, that was a special period when in different regions of the world, independently of each other, fundamentally new spiritual awareness of the essence of the existing world order was developing, including the development of the initial foundations of the concept of administrative communication relationship. Those new ideas came from the Jewish prophets of the second wave (VII–VI centuries BC) in Ancient Palestine; the first philosophers of the era of the Seven Sages (VII–VI centuries BC) in Ancient Greece; prophet Zarathustra (VI century BC) in Ancient Persia; Buddha Gautama (VI–V centuries BC) in Ancient India; and Lao Tzu (Laozi) and Confucius (VI–V centuries BC) in Ancient China. Confucius presented the most systemic and humane approach among these ancient educators of humanity at the beginning of that period of time, and some of his teachings still have an impact today. The described situation requires a deeper comprehension of the evolution of the approaches to the understanding of the relationship between administration and communication in the era of statehood incipience as it is reflected in the Lun Yu treatise of that outstanding thinker of Ancient China.

The ideas of the philosophers of that period of civilization continue to be relevant and in demand in the theoretical developments of our time. There are several directions in the works of Chinese researchers that touch upon the topics of political, managerial and ethical thought in the treatise “Lun Yu”. First, focused on the traditional identification of all aspects of “zhen” (humanity). For example, in the work of Xiao Gongquan, this concept is considered as a principle of political and social ethics (Xiao Gongquan, 1916). Secondly, devoted to the problem of governing the country as knowledge, observance of etiquette and “correction of names”. Thirdly, analyzing the methods of mutual influence in the system: government-people. Fourth, considering ways of self-improvement of the ruler. Fifth, and this special attention is given to the problem of the quality of the governing apparatus. All of these areas are analyzed in the work of Luj Czyain' (Luj Czyain', 2021, pp. 10-11). In his writings and speeches,

referring to the highlights of Confucius, Xi Jinping repeatedly drew attention to this problem (Si Tszinpin, 2021). Special studies devoted to the moral realism and ethics of the management ideas of Confucianism do not reflect the influence of the moral principles of the communication component on the sustainability and stability of the country's activity (Liu JeeLoo, 2007). Comparative characteristics of the ethical concepts of Confucius and other thinkers are given in a number of works by Yu Jiyuan and other authors (Yu Jiyuan, 1998; Yu Jiyuan, 2008; Cline, 2007). The analysis of the structure of Confucian ethics was also made without a specific emphasis on communicative features and the specifics of relationships (Cua, 1971). The making of Confucian Chinese thought in the Axial era is the focus of recent fundamental works of the English Research School at the University of Cambridge (Sterckx, 2019a; Sterckx, 2019b). The Confucius legacy is inexhaustible, like all the classics of science. Therefore, at each new stage in the science development, further refinement and filling of his models, which are fragmented in his work, are required.

The purpose of this work is to make a comparative historical analysis of Confucius' views on the phenomenon of communication in administrative processes from the viewpoint of modern understanding of this term and identify the elements that significantly influenced the development of the science of statehood.

Theoretical underpinning.

The theoretical basis of this study is the concept of communicative action and communicative ethics, embedded in the philosophical ideas of J. Habermas, K.-O. Apel and E. Dussel who justified an appropriate approach to solving social and moral problems of society (Habermas, 1996; Dussel, & Apel, 2005). From these theoretical positions, it is proposed to conduct a discussion and discourse on this issue, taking into account the highlights of K. Jaspers on the return to the origins of the modern civilizational order.

The methodology of this study adopted a systemic approach and comparative historical analysis. The history of philosophical and political thought features examples of the application of some quite reasonable ideas about the communication relationship between the authorities and people, which could serve as the basis for the formation or addition of new concepts and for the revaluation or reasoned criticism of the existing ones. The systemic review of Confucius's views is needed for additions and clarifications to be made in history regarding the new science – communication studies. And also, with the aim of improving the modern concept of a pan-civilization managerial and communication action and the theory of communication. Currently, in administrative environments there is an active search for new ideas to improve the efficiency of management decisions. Their productive implementation is possible on the way to improve the ethical interaction of communication systems of state, private and public institutions. This again indicates the relevance of paying attention to the essence of the original theoretical models, not burdened with someone else's experience and ideological influence.

A complex of general scientific and special methods of scientific knowledge is used in the study to establish the structure of the study and the logic of hindsight analysis.

Results and discussion.

The first philosophical statements about the functioning of communication in state governance date back to the VII century BC. As single expressions, they are found in the information presented by Diogenes Laertius (Laertius) about the ancient Greek sage Biantes (Bias) of Priene, who taught that one should take by persuasion, not by force, and proved this point in practice. It is necessary to speak slowly and think well before saying anything so that communication does not become a sign of madness (White, 2021). The conditions for a deeper understanding of the role of communication in the successful governance of society arose in Ancient China already in the VI – early V centuries BC. They are reflected in written sources. Herodotus, Xenophon, Socrates, and Thucydides made separate remarks on the nature of the contacts between the authorities and their subjects in the V–IV centuries BC. And only Plato and Aristotle gave the world finished philosophical works on this subject. Moreover, Aristotle was the first to develop and theoretically support a communication model (Ross, 2020). However, the first theoretical views, albeit set forth in a peculiar language in various fragments of the teacher's dialogues with his disciples, are present in the treatise of the ancient Chinese thinker Confucius.

1. Analysis of recent studies and publications.

The analysis of theoretical works devoted to the development of state and political information and communication systems, taking into account the historical experience of the past, shows the increasing attention of a number of domestic and foreign authors to historical analogies and appeals. Among them, in the context of the subject matters covered by this study in the historical political information aspect, it is necessary to name such Ukrainian authors as Yu. Beh and A. Slietsov, who examined in detail the history of the Eastern model of administration but missed the role of the communication component in this area (Bekh, & Slietsov, 2012). O. Bukhtaty, in his study, focuses only on the thinkers of Antiquity (Bukhtaty, 2018, pp. 28–29). In her work written with co-authors on the ethics of public administration, T. Vasylevska stressed the role of Confucius as the first philosopher to perceive the state as a political association of citizens (the ruler and his subjects) and called for closer ties between the people and the authorities (Vasylevska, Salamatov, & Marushevskyi, 2015, p. 7). But the authors do not mention that he was the first among thinkers to show how in a state, with the communicative interaction between the subjects and the authorities, certain moral principles should dominate; there is also no evaluation of the thinker's ethical requirements for administrative communication and its subjects. The article by P. Kretov and O. Kretova considers the historical evolution of Confucianism, but the emphasis is on its religious aspect. Also, the communication component of that process is missing (Kretov & Kretova, 2021). Other numerous works of European and Chinese authors focus primarily on the biographical data of Confucius and the development of

Confucianism in different historical periods. The ethics of virtuous interaction in the views of Confucius, Socrates and Aristotle are considered in detail in the works of Yu Jiyuan (Yu Jiyuan, 2005; Yu Jiyuan, 2008). However, the correlation with specific issues of communicative action is not reflected in them.

The need to reflect the ethical role and importance of the communication component in government is the main difference of this publication. A specific analysis of the communication concepts of Confucius, systematized into a theoretical model from the point of view of the modern understanding of the phenomenon of communication, has not been done. This study implies the beginnings of a new direction in the history of the communicative ethics action. It has prospects for revealing the essence of the humanistic approach of ancient thinkers to the problems that are relevant to the present time. This will contribute to the modern understanding of communication ethics in general. Its specifics and status remain not yet fully clarified. On the example of a number of statements of the thinker, the initial model of the communicative action is analyzed.

2. Characteristics of the era of the emergence of communicative approaches.

The historical period of the formation of theoretical administrative and communication ideas and postulates coincided with the formation of the main philosophical schools in Ancient China, which evidences the close attention of their outstanding representatives to the problems of communication between the authorities and people. A characteristic of the era known as the Warring States period was a consistent desire to establish a single centralized state and the corresponding attempts to unify the theory and practice in reforming public administration through closer interaction between the authorities in power and common people.

At that time, the ruling elites showed interest in changing and improving the existing system of public administration. As a result, a trend arose at the same time to recruit outstanding representatives of philosophical schools to the administrative apparatus. They became involved in tackling the problems of public administration, a fact that even found its expression in the creation of a philosophical and administration academy in Jixi (the Kingdom of Qi). That process was accompanied by heated disputes and a lively discourse among representatives of different philosophical schools and directions. Discussions on the formation of the principles and methods of public administration, as well as on the relations between the government, dignitaries, and people (Hu Shi, 1919), were especially broad and relevant for that time.

3. Confucius, confucianism, and awareness of the importance of the ethics of communicative action in public administration.

Among the most famous thinkers of Ancient China, the figure of Confucius or Kun Fu Ji is certainly distinguished (551–479 BC) as he was the first to pronounce and systematize his views on the issue of public administration (Ostapets, 2011, p. 363). The teachings of the thinker, presented by his disciples in the Lun Yu treatise (“Conversations and Judgments”), reflect the clear requirements for the ethics and methods of ruling the state and the people based on compliance with the norms of the

ritual (Li) and the strict following of the established rules of benevolent, balanced, and human-centered communication technology. In his judgments and conclusions, Confucius naturally relied on the centuries-old experience of large Chinese families and society as a perfect model.

In his teaching reflected in the Tao de Jing treatise (“Book of the Way and Dignity”), finally compiled at the end of the IV – early III centuries BC, Lao Tzu, a semi-legendary figure, interprets Tao as the central concept of a world view, which cannot be described by words (Lao Tszy (Lao Tzu), 2022). Confucius, on the other hand, put a completely realistic meaning into the essence of Tao as a truly correct and righteous path leading to a perfectly balanced and harmonious society. Its teachings, which later received the name of Confucianism, were intensively spreading all over China from II BC to X centuries AD. Historically, Confucianism had a different semantic content, perceived and adapted some ideas from other philosophical doctrines of Ancient China, primarily from Legalism and Taoism and the schools on the basics of classical Confucianism. Over the centuries in existence, Confucianism has demonstrated the transformation ability, communication adaptability, and resilience in different socioeconomic, political, and other conditions and systems. Also, the ancient teaching showed relevant adsorption in relation to other domestic teachings, even those directly confrontational. The interest in the philosophical heritage of Confucius was growing and spreading at first in Southeast Asia and then all over the world.

Following the logic of the theory of Jurgen Habermas, at the stage of the second communication revolution (the development of writing), Confucius was the first among thinkers of the past to put forward a system of views distinguished by the acute humanistic moral and ethical orientation of communicative action in public administration. The specificity of such a phenomenon is justified through the concept of a speech factor capable of creating universal prerequisites for a possible worldview, the process of which reveals itself as a kind of universal pragmatics of communication. Its basis is mutual understanding, mutual trust, and intersubjective recognition. This happens only if there are personalities from whom this kind of expression can be expected (Habermas, 1984). Confucius was just such a personality.

If the purpose of communicative action is to establish a consensus among the subjects of this process and balance their interests, it was Confucius who showed the means and way to achieve this within the system “the ruler - the official - the people” (the emperor - the superior man - the people). Consequently, he was the initiator of not only the theoretical approaches of outstanding thinkers of the past in assessing the positive role and significance of the state in the civilizational development of society (Confucius, Plato, Aristotle, H. Grotius, J. Locke, I. Kant) but also the apologist of speech means and communication methods, of the art of communication.

Confucius recommended that the proper distance between the masses and the authorities be always kept and promoted the concept of closed government. He believed that communicative action is best carried out through rituals. According to Confucius, communication is expressed through three key components that allow the state and society to progress in accordance with the laws of Tao. The components of Tao include three ethical principles of Confucianism that rest on such concepts as

interaction, mutual understanding, mutuality (“Shu”); golden mean (“Zhong Yong”); humanity, and philanthropy (“Jin”). The hieroglyph Jin, in turn, is consisted of two signs: a person and the number two, and represents a relationship between people; that is, it clearly points to communicative influences. These postulates are entirely and completely related to the basic principles of modern public administration and communication technologies (Ostapets, 2011, p. 364). The interaction based on mutual understanding is carried out, in a broad sense, through communication. At the same time, Confucius considered humanity as a universal embodiment of the laws of love, as a cardinal property of the human heart. But the manifestation of this feeling should take place under the conditions of mutual understanding when connections and interactions among individuals become possible, that is, communication through any means of communication between subjects. The central concept in this system of concepts is the understanding and even the feel of the Zhong Yong state that is achieved through a complex, difficult, and gradual process of comprehending the foundations of the optimum Shu when a mutually acceptable stable communication component of a collective human body, in general, is ensured.

The art of communication in the modern sense lies at the heart of Confucius’s ethics of public administration. It permeates all his philosophical teachings aimed at ascending to Tao. Such a communicative interaction, according to Confucius, is inseparable from love for a person, for people; there is a manifestation of humanity, mercy, respectability, and justice. The thinker pointed out that what is necessary is respectful and correct communication, one supporting the sense of dignity, and at the same time clearly restricted by the laws of observance of the golden mean Zhong Yong. According to Confucius, administrative communication will be effective only when the measure of manifestation and the embodiment of the principles of humanism in combination with specific deeds are clearly achieved.

4. Some ethical administrative and communication principles of Confucius and modernity.

In exercising the administrative functions, Confucius believed that the ruler needs to have special qualities because the survivability and reliability of the entire system of “administrators - subjects” depend on the presence of these qualities in him. He “needs to be careful in affairs, love people, save money and resources, and send people to work in accordance with natural conditions” (Konfutsii (Confucius), 2018, pp. 4–5). Confucius emphasized that only through direct communication and direct talking can the ruler influence the conduct of his subjects to maintain stability and respectability in society.

As an analogy of such a model of communicative action, he gives the “wind – grass” example. Confucius believed that when a ruler has all reins of power in his hands, he should only go into good deeds, and the people would immediately begin to strive for everything good. The ruler’s control system is the wind, whereas ordinary people’s minds and conduct are grass that bends down under the pressure of the wind. By applying the force of the wind (the fair mechanisms of the control system, including those related to communication), the object of administration directly affects the grass,

the subject of administration (the state and conduct of people). Thus, the mind of people trends toward the development direction chosen by the ruler, that is, the direction in which the wind blows. However, this should happen only in case of a special need. Under other circumstances, the grass naturally comes back to its initial state by the force of its internal resistance. Confucius not only emphasizes the one-sidedness and irreversibility of the communicative action of the authorities but also implies the possibility for people to restore their initial status quo, meaning the inclusion of the mental property of the subject of administration to restore its force and capabilities in accordance with the traditional interests (Konfutsii, 2018, p. 117).

The proper administration implies, as the priority and most important factor for decision-making, the critical perception of primary information and identification of it what is necessary for justified actions. In saying that, Confucius points out that it is necessary to pay attention to the nature and form of administrative communication. First of all, he believed the form of communication should be polite and respectful, unbiased, and sympathetic but without prejudice. He also promoted a critical approach to other people's opinions because entertaining them too much "brings only harm" (Konfutsii, 2018, p. 14).

Confucius argues that it is with the help of such direct communication that corresponds to the model proposed by him that the fulfillment of the relevant political requirements and the successful implementation of administrative decisions in the state is possible. He was not a democrat in the meaning generally accepted in the European liberal understanding, as he always recommended a reliable and sustainable distance to be kept between the authorities and the masses based on the actual social structure of society. There were no forms close to democratic ones in China, neither before nor after the lifetime of Confucius. He considered the economic, educational, and moral factors as the key reins of fair influence on the people in order to encourage them to productive work. Therefore, people should first be fed, taught, and brought up. The ruler should "care more about any disproportionate distribution of wealth rather than its absence, and about the lack of well-being rather than a small population. With proportionality, there is no poverty, and when harmony reigns, there is no shortage of people; where well-being is prioritized, there are no upheavals" (Konfutsii, 2018, p. 167).

As follows from the logic of the philosopher, the communication coming from the authorities should be limited in order to avoid exciting people with any contradictions and disputes that arise in the administrative circles. The opinion about Confucius's anti-democratism is due to the taking of his specific postulates isolatedly, without considering their logical connection with the whole context of his statements. He was not against the freedom of statements and judgments. On the contrary, he emphasized, "The superior man does not promote a man simply on account of his words, nor does he put aside good words because of the man!" (Konfutsii, 2018, p. 160). This remark sounds especially relevant to modern media and communication. "Humanism rarely comes along with skillful speeches and a touching facial expression" (Konfutsii, 2018, p. 4). He unequivocally emphasized the significant role of the communication component and its influence on the rational existence of a state. Confucius also drew

the attention of his disciples to the nature and power of the communicative influence, which could cause a specific reaction in society or have a specific effect on the situation of a state.

In his principles and in the ethics of the communicative impact on the people, Confucius consistently defended the ideas of humanity, nobleness, traditionalism, morality, abstinence, and care to be adopted by the ruler and the entire administrative apparatus of the state. The central figures to whom he conventionally addressed these ideas were the ruler as an unlimited subject of administration, whose will, characteristics, and virtues determined the stability and prosperity of the state and the state officials (the superior men) as a professional and well-functioning executive mechanism for ruling the people. The people acted as passive subjects, accurately perceiving and reflecting all communicative actions to their reactions and conduct.

The approximate fragmentary ethical model of administration and communication in a state, presented by Confucius, could be possible only if there were an apparatus of perfectly moral public servants. At the same time, the entire society should strictly observe the norms, rules, and traditions of the Li, with the complete isolation of the state from the external world from any outside influence. Confucius realized this and, in his conversations with his disciples, often emphasized a significant difference between his ideas and the reality of administrative practice. Even approaching the ideal, he believed, would require the stubborn and consistent work of several generations of ideologically mature administrators and rulers. Such a model was perceived in China as an ideal example for one to keep in mind, yet never feasible.

And humanity has been living up to this day on the legacy of Confucius regarding the ethics and methods of communicative action, created and thought out then, and each new rise has been accompanied by an appeal and returns to the “Axial Age” (Jaspers, 2017). In Chinese reality, that was the time between 600 and 300 BC, when the basic principles of the ideal Confucian and administrative and communication ethics were developed and established in society, as well as ideas from many other teachings intensively adopted.

Conclusions.

The analysis of the primary sources regarding the appearance of the first systemic ideas in the history of science regarding the role, form, and meaning of communication in centralized public administration contributes to the rethinking of the conceptual ideas of modern communication science. Based on the chosen research methodology, relying on the classical philosophical concepts of J. Habermas, K. Jaspers, K.-O. Apel, managed to typify the invisible spiritual connection between the communicative ideas of the Axial time that arose in ancient China and modernity. Despite the fact that the first bold, intuitive conjectures about the role and nature of communication in the interaction between the authorities, government officials, and people existed back in the VI–V centuries BC, individual scientific developments on these issues started off only in the middle of the twentieth century. Since the understanding of the communication phenomenon in full, begins to occur only in our time, the first time the special roll call meaning of the first and last concepts concerning the ethics of

communicative action in social management is emphasized and revealed in this study. The purpose of the study is achieved by showing Confucius as the first of constellation of thinkers of the Axial era, who presented a model based on a comprehensive vision of the human nature of state communication. He was a consistent initiator of a positive attitude to the centralized ruling of a country on the basis of compliance with the traditions and norms of respectability and philanthropy. Confucius focused on promoting the optimum forms of social organization on the basis of the best qualities of those who are in power and those who are the subjects. The balance of this ratio as the basis for the statehood development ensures, according to the leading thought of Confucianism, the dominance of order and tranquility in the country. The legacy of Confucius, in part concerning his understanding of communication, can be continued to identify the full scope of his statements on communication and related issues.

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Денис Кіслов

Товариство з обмеженою відповідальністю “Міжнародне бюро корпоративної аналітики і консалтингу”, Україна

Управлінсько-комунікаційні погляди Конфуція

Анотація. У статті розглядається проблема формування теоретичних поглядів на характер, методи та практику управлінсько-комунікаційної діяльності суб'єктів влади стосовно населення держави у VI–V ст. до н.е. у Давньому Китаї. Виявлення комунікаційних ідей здійснюється, насамперед, на основі трактату Конфуція “Лунь юй”. За методологію дослідження прийнято системний підхід і порівняльно-історичний аналіз, що дозволяють виявити елементи, які пов'язані з поглядами мислителя, визначити їх значення в історії теорії управління та комунікації, в документах китайської дійсності. Показано умови політичної та економічної життєдіяльності Давнього Китаю того часу, що сприяли появі філософських концепцій конфуціанства з управління державою та комунікаційних взаємовідносин. Встановлено послідовність та відмінну особливість гуманістичних і морально-етичних поглядів Конфуція на функціонування комунікаційних схем держави, які й досі залишаються актуальними для розвитку науки та практики. Основну увагу приділено аналізу конкретних суджень мислителя про структуру комунікації в управлінському середовищі. Розкрито комунікативне наповнення визначальних складових основного світоглядного поняття (“Дао”) його вчення. Розглядаються причини пропаганди закритості влади та дозування інформаційних потоків в управлінському середовищі та спілкуванні чиновників з масами. Аналізуються засоби, що запропоновані для адекватного сприйняття населенням (підданими) рішень влади. Це завдання досі активно обговорюється у сучасній комунікативістиці. Дано тлумачення деяких висловів Конфуція, що визначають морально-етичні рамки комунікації управління, розкрито зміст його комунікаційної моделі. Відзначено особливості цієї ідеальної фрагментарної комунікаційної моделі як зразка, що обмежений для практичного застосування багатьма об'єктивними умовами. Вказані часові рамки “осьової епохи” в історії

Китаю. Зроблено висновки про роль і значення поглядів Конфуція у становленні та розвитку способів та етики комунікативної дії при управлінні державою в історичному та перспективному плані.

Ключові слова: державне управління; комунікація; народ; Давній Китай; етика комунікативної дії

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**The history of the creation, formation and development of the Museum of
Theater, Music and Cinema Arts of Ukraine**

Abstract. *The authors analyzed the stages of creation, formation, development and modern activity of the Museum of Theater, Music and Cinema Arts of Ukraine, which is the only one in Ukraine in terms of its specialization. This museum has a*



history famous for its names and events. It is widely known in Ukraine and abroad for its permanent exhibitions and mobile exhibitions, created on unique exhibits from the history of theater, music, and cinema. Collected during its existence – since 1923 – a large and multifaceted collection of monuments from the history of the development of arts, which is constantly replenished with new materials, is the basis for scientific research, scientific advisory, expository and exhibition work, a rich source for popularizing the achievements of the national theater, music and cinema. The article emphasizes that theater museums, film and music museums are an integral part of the development of world culture. They arose, developed and formed into a separate typological group of art museums. The uniqueness of each theater museum was determined by stationary expositions and temporary exhibitions, which were the main sphere of operation and a form of use and popularization of the processed funds. Reproducing the phenomena and events of the theatrical heritage, expositions and exhibitions visualized the most significant assets of both the past and modern theater and theater science in the language of museum exhibits. Research and analysis of the historical experience of exposition and exhibition activity of theater museums, film and music museums will be important for an objective assessment of the positive and negative consequences of the influence of national and cultural processes on their functioning and development. The challenges faced by theater museums, film museums and music museums in the course of their activities have common features and may vary depending on the specific situation and context. The article analyzes the typical problems and features that theater, film and music museums face in their activities. The article shows that these problems may differ for each specific theater museum depending on its size, financial resources, location and other factors. Their features may vary among theater, music, and film museums, depending on their resources, scale, and specialization. However, solutions to these challenges may include working with conservation professionals, attracting grants and sponsors, developing educational programs, and using new technologies to improve visitor audience engagement.

Keywords: museology; theater museums; film museums; music museums; Les Kurbas; Petro Rulin

Introduction.

Theater museums, film museums and music museums have unique features in the collection and presentation of their collections (Bronner & de Hoog, 2019; De la Vega, Suarez-Fernández, Boto-García, & Prieto-Rodríguez, 2020; Nogare & Murzyn-Kupisz, 2022). Here are some features that are characteristic of these types of museums.

For Theater Museums, such features are the following (Proietti, Panella, Leccese, & Svezia, 2015; Davis, Norwood, Smyth, & Weltman, 2021; Schiavinatto & Lima Junior 2022.).

1. Costumes and accessories. Theater museums store various costumes and accessories that were used in performances of different eras. These elements demonstrate the development of theater design and style trends in different eras.

2. Decorations and models. Theater museums may also have models of sets, sets and props used in performances. This allows visitors to better imagine the theatrical atmosphere and explore the process of creating scenography.

3. Archive materials. Theater museums also store archival materials, such as posters, programs of performances, photographs, correspondence and other documents related to the history of the theater and its outstanding productions, which help to recreate the history of theatrical art and the lives of outstanding actors and directors.

4. Sound recordings and video materials. Some theater museums also include an archive of sound and video recordings of performances, concerts and other theatrical events.

For Cinema Museums, the following features are (Thomson & Chatterjee, 2015; Wickham & Hanson, 2022; Fabrizi, 2023):

1. Film cameras and other equipment. Film museums store different types of film apparatus and equipment that were used in different eras of cinematography. These can be exhibits in the form of early cameras and projectors that were used at the beginning of the history of cinema, sound systems and other devices that demonstrate the evolution of cinema.

2. Posters and advertising materials. Film museums keep collections of movie posters and advertising materials. These elements reflect the different design styles and marketing strategies that have been used to capture the attention of viewers.

3. Archives of films and video materials. An important part of film museums is the preservation and presentation of archival films and video materials. They have collections of classic, historical and cult films that represent significant aspects of cinema.

4. Props and Costumes. Film museums may also hold collections of props and costumes from famous films. These objects demonstrate the process of making films and the development of cinematographic art.

5. Technological progress. Film museums reflect technological advances in the film industry, including the development of cameras, film projection equipment and special effects.

The collections of Music and Musical Arts Museums have their own characteristics that reflect the diversity and richness of musical culture (Fairchild, 2017; Cortez, 2019; Baker, Istvandity, & Nowak, 2020). Here are some elements that can be attributed to the general features of these collections.

1. Musical instruments. Music museums store a wide range of musical instruments from different eras and cultures. These can be keyboard instruments, string instruments, wind instruments, percussion instruments and many others. Some of them may be rare or unique specimens. The instruments are on display and some can even be played.

2. Archives and documents. Music museums have archives containing sheet music, manuscripts, scores, composers' letters, concert programs, photographs, recordings and other documents related to the history of music. These materials reflect the development of musical art, the life and work of composers and musicians.

3. Sound recordings. Recordings and audio recordings: Music museums may have collections of recordings that represent different genres and eras. These can be old gramophone records, cassettes, CDs, digital recordings and other sound carriers. They demonstrate the development of music recording technologies and important musical performances.

4. Exhibits about great musicians. Many music museums have exhibits related to great composers, musicians, and singers. These can be personal items, musical instruments, recordings of performances, costumes and other items that tell about their life and work.

5. Thematic exhibitions. Music museums hold temporary exhibitions and expositions dedicated to various aspects of musical art. These can be exhibitions about specific composers, musical styles, genres, historical periods and other topics that reveal the diversity of music.

These features help theater museums, film museums and music museums to create a unique atmosphere in museums, allowing visitors to better understand the history, development and impact of musical art on culture and society.

Probably one of the oldest museums with musical instruments in their collections is the Ashmolean Museum in Oxford (Warnett, Williams, Wilson, & Smith, 2021). According to some data, the Ashmolean Museum in Oxford is generally the world's oldest publicly accessible museum (Martins, 2021). The year 1683 is considered to be the founding date of the Ashmolean Museum (Veronesi & Martín-Torres, 2022). The extremely rich collection of musical instruments of the Ashmolean Museum has such valuable exhibits as the Messiah Stradivarius, a violin made by Antonio Stradivari (Gonzalez, Salvi, Baeza, Antonacci, & Sarti, 2021), as well as, of the guitars, probably the best-known example, dated 1688 (Pollens, 2003, p. 207).

However, the Ashmolean Museum in Oxford is not a specialist music theater or film museum. Bakhrushin State Central Theater Museum (Schüßler, 2022, p. 33), located in Moscow, Russian Federation, is considered to be one of the oldest specialized museums (music theater or cinema) in the world. It was founded in 1894 and became the first specialized theater art museum. Bakhrushin State Central Theater Museum has a rich collection that includes a variety of artifacts related to theater history, including costumes, props, posters, photographs, manuscripts, puppets, and other equipment. The museum is dedicated to preserving and displaying the history of theatrical art, researching the development of theater and its influence on society.

Among other world-famous theater museums, it is worth mentioning the Austrian Theater Museum, which celebrated its 50th anniversary last year in 2022 (Dembski, 2005). Founded in 1975 in Vienna, the Austrian Theater Museum was located in the Lobkowitz Palace, which used to be the city's most important palace. The palace was built for Philipp Sigmund von Dietrichstein after the second siege by the Turks in 1683. Currently, the museum exhibits more than 100,000 engravings and drawings, more than 1,000 stage models, about 600 different models of theatrical costumes, and more than 700,000 valuable photographs of directors, actors, and composers. One of the brightest and most valuable exhibits exhibited in the museum is Teschner's marionette theater, which is called "The Golden Cabinet". In addition, true fans of the theater will

be interested in the museum library, the collection of which includes about 80,000 books. This museum is one of the largest and most prestigious in the world, and it serves as an example for many other theater museums that strive to preserve and display the history and significance of theater art.

In general, the year 2022 seemed to be rich in various holiday dates and anniversaries of theater, cinema and music museums.

The Theater Museum in the Court Theater in Copenhagen (Denmark) celebrated its 110th anniversary in 2022 (Grandjean, 1997). The museum was originally founded in 1912 by a private group of theatre enthusiasts. Under the leadership of Robert Neiiendam (1880–1966), the head of the Theatre Museum at the Court Theatre, it was moved in 1922 to the old Court Theatre. The Theatre Museum at the Court Theatre develops and disseminates historical and current knowledge about Danish theatre and performing arts in and from the context of the old Court Theatre from 1767. It is also the task of The Theatre Museum to cherish and maintain the Court Theatre for its unique, cultural and historical values in a national as well as an international context. The Theatre Museum at the Court Theatre is an empathetic, open, vibrant and courageous host and curator of activities in and around the museum and the Court Theatre. Theatre and the performing arts are the reflection of the cultural, intellectual and social atmosphere of the time. The Theatre Museum at the Court Theatre is Denmark's key player for study, discussion and dissemination of past, present and future cultural trends, such as they are reflected in and presented by the theatre and the performing arts.

The Theater Museum in Warsaw celebrated its 70th anniversary (Wieczorek, (2020). The Theatre Museum in Warsaw is the first and only museum that collects theatre artefacts from across Poland. Established in 1957 on the initiative of Arnold Szyfman, it holds exhibitions in Warsaw and other Polish cities. Its rich collection benefits both researchers and the general public.

Founded in 1962, the Finnish Theater Museum in Helsinki celebrated its 60th anniversary (Pettersson, 2011, p. 288). The Theatre Museum's recording plan and collections policy are determined by its status as a museum with national responsibility. The Theatre Museum's in Helsinki maintain the national collection of Finnish theatre, dance, opera, circus and live art and performance primarily focusing on Finnish professional activities, as well as collecting material on organisations and professionals in the field.

The 40th anniversary was celebrated at The Theater Museum Canada was founded by Herbert Whittaker in 1982 (Barris, 2007). Victoria Côté wrote: "Its mandate is to collect, document, preserve, study, display and interpret the heritage of theatre in Canada, and to enhance the public appreciation of theatre. The museum continues his legacy of nurturing theatre in Canada, and his designs form the core of the museum's collections. Theatre Museum Canada seeks to share the wonder of Canada's rich theatre legacy with Canadians and theatre enthusiasts everywhere".

The Museum of Music in Paris celebrated its 25th anniversary. The world-famous Museum of Music in Paris opened its doors to visitors in 1997 (Hammoutene, 1997). It is part of the Concert Hall of the Philharmonie in Paris and contains a wide range of

historical and modern musical instruments. Within the Philharmonie de Paris, the Museum of Music represents a collection of more than 8,000 instruments and art objects, with almost 1,000 on exhibit in the permanent exhibition space, including national treasures and legendary instruments such as a piano belonging to Chopin and a guitar belonging to Brassens. The museum presents a history of Western music from the 17th century to today and an overview of the main musical cultures of the world. What makes the Museum of Music so colourful is the temporary exhibitions it hosts alongside its permanent collection. Always on the theme of music, these exhibitions bring together different artistic disciplines and areas of the world, with complex thematic angles.

2023 also seemed to be rich in the anniversaries of theater, cinema and music museums.

The Tsubouchi Memorial Theatre Museum, Waseda University, will celebrate its 95th anniversary in 2023 (Kang, 2022). With the aid of supporters from a range of fields, The Tsubouchi Memorial Theatre Museum, Waseda University, familiarly known as "Enpaku", was founded in October 1928 to commemorate the 70th birthday of Professor Tsubouchi Shoyo and the completion by him of the translation into Japanese of all 40 volumes of the "Complete Works of Shakespeare", a task to which the Professor had devoted half his life. Since then, as Asia's only museum dedicated solely to the theatre, Enpaku has been engaged in collecting works relating to the theatre and motion pictures both in Japan and all around the world. Its extensive collection of about one million works that has been amassed over 85 years may be termed as "the history of theatre" itself. Meanwhile it also contributes to researchers from a wide range of fields, extending from the theatre and motion pictures to other areas such as literature, history, clothing and construction.

In 1988, a film and television museum opened in London, which became known to the public as the Museum of Moving Images (Fabrizi, 2023). It contained the richest collection dedicated to the history of cinema from the very first steps of its development. But in 1999, the museum had to be closed due to lack of funds. Its future remained unclear for a long time. In 2008, part of the exhibits under the name "Movieum" became part of the new London Museum of Cinema. Movieum became a branch of the museum in the South Bank area. Movieum was organized by Jonathan Sands following the success of the 2007 Star Wars exhibition. More than half of the collection was taken from Sands' private archive. In 2010, the name "Movieum" was abandoned in favor of "London Film Museum". The museum has good relations with film studios and collectors, so the collection is constantly replenished.

Also in 1988, the Museum of the Moving Image (Queens, New York City) opened its doors to visitors (Jakovljevic, 1996). Since its opening in 1988, Museum of the Moving Image has been recognized as a major, internationally reputed institution and the only museum in the United States dedicated to exploring the art, history, and technology of the moving image. The Museum occupies one of the thirteen buildings that comprised the former Astoria studio complex. Originally built by Famous Players-Lasky – known as Paramount after 1927 – as their East Coast production facility in 1920, the studio was the site of hundreds of silent and early sound era film productions.

The Museum's mission is to advance the understanding, enjoyment, and appreciation of the art, history, technique, and technology of film, television, and digital media. The Museum fulfills its mission in person and online through temporary and permanent exhibitions; film screenings; live conversations with artists, filmmakers, scholars, media educators, and other industry professionals; articles published in MoMI's online film magazine *Reverse Shot* and science and film resource *Sloan Science & Film*; access to the Museum's collection of more than 130,000 objects; and the online presentation of a range of films—including acclaimed new release features and award-winning science shorts, plus archived video of Museum events, and more. The Museum's Education department serves approximately 70,000 students each year, through guided tours of its exhibitions, educational screening programs, and hands-on workshops.

The authors of the article were interested in another significant event of 2023 in the world of theater, film and music museums. On January 30, 1923, a theater museum was founded at the "Berezil" Art Association, headed by the prominent Ukrainian theater figure Les Kurbas. Nowadays, it is the Museum of Theater, Music and Cinema Arts of Ukraine, which will celebrate its centenary in 2023 (Ovcharenko, 2020; Zinkiv, 2021; Veselovska, 2022a). During its creation and existence, the museum faced difficult times and stages. The authors of this study believe that a retrospective analysis of the stages of creation, formation, development and current state of this unique institution will be interesting to a wide international audience.

The purpose of the article is to highlight the activities of the Museum of Theater, Music and Cinema Arts of Ukraine and determine its role in the processes of revival of national priorities in 1923–2023.

Research methodology.

The research methodology is based on the application of the comparative cultural-historical method, with the help of which the facts of the revival of the national tradition related to the activities of the museum and the method of source research are analyzed (Cherhik, 2021; Strelko, 2021; Pylypchuk, et al., 2021; Strelko, et al., 2021). Based on the analysis of archival and published material, the perception of the contribution of the Museum of Theater, Music and Cinema Arts of Ukraine to the process of revival and preservation of the Ukrainian national tradition has been significantly expanded.

Results and discussion.

Serhiy Rudenko in the "Introduction" to his article "Kurbas: to save" notes: "Usually the role of museums in modern life is underestimated. According to common perceptions, these institutions collect used cultural material, interesting only for culturalists, art critics, historians (cabinet scientists, not practitioners) – or for visitors who escape into the past from real life. However, the connection of museums with the present is no less close with the past. In many ways, it is museums that shape our future" (Rudenko, n. d.).

It's a pity, but Ukrainian culture in general and artistic creativity in particular too often imitates models of foreign culture and spends unnecessary efforts on their

adaptation to local realities (Revko, Butko, & Popelo, 2020; Proskuryakov et al., 2022; Suveica, 2022;). And as life shows, adaptation negates the creation of something new. And yet, Ukrainian culture had successful forays to the world level. As an example, let's mention the Ukrainian avant-garde of Les Kurbas, who personifies it (Maystrenko-Vakulenko, 2021; Harbuziuk, 2021; Veselovska, 2022b). Today, it is believed that "the impulse given by the Ukrainian theatrical avant-gardes will help us to leave the ranks of the eternal pursuers of progress and finally lead it, adapting the innovative trends of artistic culture to Ukrainian realities. The task of museums is to intensify the use of historical and cultural heritage to solve modern and future problems. That is why it is necessary to carefully examine the obstacles that may stand in the way of the formation of museums working for the sake of the future" (Rudenko, n. d.).

The words of Petro Rulin (1892–1940), a Ukrainian theater expert and teacher, should be added to what has been said. He graduated from the philological faculty of Kyiv University, a professor of the history of Ukrainian and world theater at the M. Lysenko Music and Drama Institute (1920–1934) and the director of the Kyiv State Museum of Theater Art of the Ukrainian SSR (1926–1936), who emphasized as far back as 1927: "Of all the branches of art that have defined their material and boundaries, the art of theater seems to be the latest to become an object of scientific study. Both the actors of the theater and its researchers often expressed their admiration for the impermanence of theatrical art, the ephemerality of its creations and achievements. When histories of the theater were written, they were mostly focused on the history of the drama itself, or at best – and very rarely – on the organizational forms of theatrical life; were interested here in questions about how, on whose initiative this or that theater arose, what were the relationships between individual co-participants, etc." (Rulin, 1927, p. 3). In 1936, he was arrested by the NKVD of the USSR and executed in a prison in Magadan. Posthumously rehabilitated. P. Rulin researched the history of Ukrainian theater and Ukrainian drama, the dramatic work of Taras Shevchenko, Panteleimon Kulish, Mark Kropyvnytskyi, Mykhailo Starytskyi, and the theatrical activities of Maria Zankovetska, Mykola Sadovskyi, Anna Borysoglibskaya, and Les Kurbas.

Petro Rulin also notes that the attractions were mainly about the past, more often about individual actors (Nesen, 2021). However, this was not done because any scientific tasks were clearly and precisely set. As a rule, things were collected as relics associated with one or another expressive moment or figure of the theater. The author of the work "Ukrainian Theater Museum: Tasks and Prospects (Kyiv, 1927) P. Rulin believes that if hundreds of different art museums existed and developed, then separate, very rare units were museums that considered the collection of theatrical items and in such a way to develop theatrical art. To this should be added, said P. Rulin, that such museums were often attached to certain theater institutions, collecting almost everything related to the theater and thereby supporting the glorious traditions of one or another theater. P. Rulin noted that the museum at the Paris "Comedie Francaise", the "Dresden Theater Museum", the museum at the former theater in Leningrad, the "Moscow Artist" and the "Grand Opera House" in Moscow had this character. However, sometimes the interests of theater museums had a wider range. So, for

example, the museum at the famous opera house "La Scala" in Milan collected all kinds of theater sights.

Then P. Rulin writes: "And it is now that the collections of these museums acquire extremely great scientific significance. The history of the theater finally realized that it cannot be limited to the study of only one of the factors of theatrical art - drama; in recent years, it has been looking for its own ways, sometimes coming close to neighboring fields of art, painting and architecture in particular" (Rulin, 1927, p. 4).

It is clear to us that when researching this or that moment in the history of the theater, a scientist must look for different types of materials. In this context - setting before themselves a certain task - the reproduction of a theatrical spectacle in the whole set of all its elements - theater historians try to find out how all the factors of the performance looked and sounded and how the audience of that time, for which the theater existed and from which it was fed, perceived it .

Thus, the theater museum, which reflects various factors of the theater with its monuments, is important for the research of the past of the theater. Finally, the theater museum must look not only backward, but also forward. "With his collections, he must reflect the current state of theater art, be the center in which each of his workers, even provincial ones, can learn about the latest achievements of theater culture" (Rulin, 1927, p. 5).

According to the convictions of P. Rulin: "The Ukrainian Theater Museum must be an institution: 1) which concentrates the sights and materials needed for researching the past of the theater; 2) how, going to the level with theatrical life today, reflecting the achievements of each season, will rule for a permanent exhibition of modern theater art in Ukraine, thus spreading its new currents outside the boundaries of large centers of theatrical culture" (Rulin, 1927, p. 4).

The date of establishment of the " Museum of Theater, Music and Cinema Arts of Ukraine" is considered to be January 30, 1923, when at the "Berezil" Art Festival, headed by Les Kurbas, a museum commission was formed consisting of theater actors: V. Vasyenko-Milyaev, L. M. Hakebush, L. Serdyuk, O. Shvachko and P. Masokha. The head of this commission was the director of the "Berezil" Association, Vasyl Vasyenko-Milyaev (Vasyenko-Myliayiv, 1926). At that time, it was an unprecedented step both for avant-garde artistic associations and for the museum business (Vasyenko-Myliayiv, 1929). The avant-garde has always been closely associated with futurism. The leading idea of this trend, which was formulated by Filippo Tommaso Marinetti, was the idea of eliminating the previous cultural and artistic experience that prevents modern artists from creating truly new art (Fatta, 2020; Roca, 2021; Paoletti, 2022). In this regard, Candidate of Cultural Studies Serhii Rudenko says (Rudenko, n. d.): "Like many contemporary utopians, the futurists did not notice the logical contradiction of this thesis. If we destroy all previous experience, how can we know that now it is the creation of new artistic models, and not the repetition of rejected old art? How can you stand on the shoulders of giants if those giants have been overthrown? How to find out about the progress of the global artistic experiment, which was permeated with avant-gardeism?"

The fact of the creation of a museum commission at the most radical avant-garde artistic association in Ukrainian lands testified that the "people of Berezil" were aware of the outlined problems. The commission believed that in order to abandon artistic experience, it is necessary to thoroughly research it. An artistic experiment, which was engaged in by actors from Berezil, as well as other representatives of contemporary art in the 20s and 30s of the 20th century. should have been carefully documented for future experimental artists to move forward rather than repeat the past. Therefore, the museum was already considered a center of theater development in those days.

Without having a special room, without any funds, this commission has done a lot in three years. In one large room of the foyer of the former Solovtsov theater and in two small rooms, a considerable part of the three thousand exhibits that the commission managed to collect were exhibited. However, this process was hindered by a situation that inhibited the development of the Museum. The "Berezil" theater was a party organization, and sharp disputes constantly arose in the artistic groups of that time. The Museum was met with mistrust by some, and even hostility from others, who did not like the exhibits collected by the Museum. The museum aspired to move into a different arrangement, especially into some academic institution. An incident helped. In 1926, the "Berezil" theater moved to Kharkiv, but to much worse premises. No room was found for the Museum. Therefore, the Management Board of the "Berezil" Theater willingly agreed to the proposal of the Ukrainian Academy of Sciences to transfer the Museum under its control. Soon, on May 29, 1926, such a transfer took place. However, until June 19, 1927, the museum exhibits were preserved in wooden boxes in the premises of one of the buildings of the Lavra State Museum Register. The Museum could not start its activities for a whole year, due to a number of reasons: lack of funds in the Academy's budget, repair work, not even one full-time unit was received. And only from May 1928, when funds were allocated from the Academy, special assistance was received from the Regional Executive Committee, the museum began to work and there was hope for its further development, so that all the achievements of the Ukrainian theater, starting from the time of its creation, would be concentrated in Kyiv.

The staff of the Museum realized that it is in Kyiv that the existence of the Museum is most appropriate – the entire development of the Ukrainian theater is most closely connected with Kyiv. In Kyiv, starting from the 17th century, there was a higher school of Ukraine – "Spiritual Academy", in which, along with the development of various religious tasks, the first sprouts of the Ukrainian theater were born. In the Fraternal Monastery of the Kyiv Theological Academy, starting from 1734, the Congregation Hall functioned, in which theatrical performances took place. As a matter of fact, educated Kyiv bursaks, singers and actors came out of this Academy, who spread a new form of religious drama through Vertep, which gave excellent examples of folk theater in the form of interludes. Theater life in Kyiv began to develop actively. At that time, two of its currents – Polish and Russian – converged here. Ukrainian theater grew under their influence. The famous amateur performances of 1872 and 1874 were held in Kyiv, organized by M. P. Starytskyi and M. V. Lysenko. Kyiv became the only city in Ukraine in which there was a permanent Ukrainian theater with

M. K. Sadovsky at the head. The most famous theaters of the time of the civil war were born and existed in Kyiv – "State National", "Molodiy", "T. Shevchenko", "Zankovetska", "Berezil" (Muzei teatralnoho, muzychnoho ta kinomystetstva Ukrainy, n. d.).

The Theater Museum was intended to collect a huge number of Ukrainian historical monuments from various cultural institutions, its purpose was to demonstrate the achievements of culture and art to the general population, to promote theatrical art. The Theater Museum set itself the task of highlighting the theater not only of Ukraine, but of all parts of the world, especially the theater of the peoples who lived on the territory of Ukraine. In his articles, V. Vasyenko-Milyaev constantly emphasized that the Theater Museum is a national institution. Therefore, he called on everyone to discuss museum representations – joint work for the benefit of the formation of modern Ukrainian theater based on the study of historical exhibits. In this regard, Serhii Rudenko notes: "V. Vasyenko-Milyaev drew attention to the fact that the Museum should become a center of human transformation - but not mass transformation, in accordance with the technologies of Soviet propaganda, but individual – in accordance with personal intellectual background, life experience, and subjective assessments. Everyone should find something for themselves in the Museum. The founder of the Theater Museum noted that "the museum must be a research laboratory, where a director, actor, artist, choreographer, composer, theater machinist, electromechanic, props, critic, historian, and finally, an amateur could familiarize himself with the history, development and the latest achievements of the field of theater that interests him" (Rudenko, n. d.).

S. Rudenko draws our attention to the fact that V. Vasyenko-Milyaev considered the museum as a "research laboratory" (Rudenko, n. d.). Kazimir Malevich also expressed a similar attitude to museums as centers of future design a little earlier (although he was earlier on futurist positions) (Maystrenko-Vakulenko, 2021). The meaning of the social laboratory is to experiment in controlled conditions, not carelessly in life, avoiding possible negative consequences. However, since the experiment of the residents of Berezil took place directly on the stage, and they themselves considered the theater as the main means of transforming the world, the museum still performed an auxiliary function. The expositions of the "Berezil" theater depicted the evolution of the formation of the Ukrainian theater. Here, the popular at that time scientific approach and the transfer of laws of natural processes to social phenomena are noticeable. However, the experience of "Berezil" theater showed that this concept was wrong. The initiative of the people of "Berezil" and their desire for development had no clear prerequisites and were ultimately artificially suppressed by the Soviet system. The promoted idea of a museum-laboratory was not realized – the museum did not exist for long. V. Vasyenko-Milyaev could reasonably expect that the research and laboratory potential of the museum would be realized later, under the auspices of the Academy of Sciences.

As we have already noted, during 1926–1927 the Theater Museum was transferred to the sphere of administration of the All-Ukrainian Academy of Sciences (UAS). At that time, the Museum was headed by theater expert Petro Rulin. The basis

of the museum collection was the monuments accumulated by Berezhil museum workers. The collection was properly organized and accounted for. The main directions of fund selection were determined. P. Rulin began to form the scientific collection of the Museum and completed it with the preparation of a separate book entitled "Ukrainian Theater Museum: Tasks and Prospects". The principles of avant-garde museology continued to determine the nature of the institution's functioning. An experimental approach to the selection of museum monuments was preserved. It was at this time that Petro Rulin began to expand the profile of the museum - he began to replenish it with monuments of musical and cinematographic art. At this time, an active search for new means of expression began, and in cinema, the youngest type of artistic creation, all efforts were directed to finding a specific film language.

Serhii Rudenko notes in this regard: "The trend of correlation of the profile of institutions, according to the scientific classification of artifacts, became widespread in the museum industry at the time. The synthetic approach contributed to the transition to conceptual representations, where the leaders were not objects, but a complex of ideas that they are able to reflect" (Rudenko, n. d.).

Thus, the Theater Museum established itself as a center of innovative curatorial practices. And this was manifested in the exhibition work. As you know, scientific results are expressed in texts (monographs, textbooks), and the exposition illustrates them. During the activity of P. Rulin, the exposition actually became the place for the first publication of scientific works and created a model for understanding the history of the theater. It is a pity that over time the original avant-garde design of exhibitions of the 20s and 30s of the 20th century changed to a classic architectural and artistic design with typical shop windows. Along with this, in these years, the museum was actively equipped with photographs, reproduced printed products. Thanks to the collections, the source base for scientific research in the field of culture and arts was significantly expanded. An important acquisition of the Museum was a complex of theater dolls, starting from the Ukrainian nativity scene of the 18th century. to the avant-garde political cradle of the 20s of the 20th century.

Petro Rulin believed that the main task of the Museum is to inform and educate. He noted that the exposition was supposed to reflect the results of the conducted scientific work. In the 1930s, scientific criticism was supplanted by political and ideological expediency. The totalitarian system was hostile to attempts to preserve a scientific approach to museum representation, to avoid ideological deformations and to level the significance of the museum monument as a scientific fact. Therefore, the first director of the Theater Center of the Ukrainian Academy of Sciences was arrested in 1936 during mass repressions against the intelligentsia.

With the strengthening of totalitarianism in the 1930s and 1950s, the Museum's avant-garde collection was under threat (Kocherga & Visych, 2020; Moldovan, 2022; Oliynyk, 2023). In the 20s of the XX century, the newly created USSR needed a new culture that would replace the culture of the Russian Empire. Especially the new government supported such a trend as futurism, which aimed to destroy the previous experience. After all, artistic experiments within the new socialist culture became dangerous for the Soviet authorities. Socialist art began to threaten the ruling class, as

it exposed the shortcomings of the Soviet government. That is why in the 30s of the 20th century, socialist realism began to develop, the purpose of which was to demonstrate the ideal Soviet life. In fact, cultural work has been replaced by propaganda. Such a turn had far-reaching consequences for the development of culture in Ukraine, this inertia is still felt in modern Ukraine.

Here we smoothly approached the necessary analysis of the totalitarian and post-totalitarian periods of the development of museology in Ukraine. However, this is the topic of a separate study and we plan to conduct it in our future work. The problem of state policy regarding avant-garde monuments in the country's museums, the characteristics of individual funds in special storage facilities, at least in the basic former Soviet museums, the characteristics of the revision of museum funds, their extermination and repression of museum employees deserve special attention. Therefore, we are only specifying the main milestones in the development of the Museum of Theater, Music and Cinema Arts of Ukraine. After the World War II, it slowly returned to full-fledged activity. The collection of almost one hundred thousand was re-accounted for, the Museum continued to deal with acquisitions, temporary exhibitions were held, museification developed, and the theatrical activities of Ukrainian stage artists (for example, M. Zankovetska and M. Lysenko) were highlighted. In 1977, a permanent exhibition was completed. Since the museums in the former USSR belonged to the propaganda system, they were mostly politicized and quite conservative in matters of returning forgotten names. The Ukrainian totalitarian model was characterized by high ideological and propaganda discipline and prevention of dissent, loyalty to the interpretation of repression.

"That is why – Serhiy Rudenko notes – in Ukraine, the implementation of the Kurbas museum projects faced serious obstacles, which posed very real threats to the initiators of the restoration and return of Ukrainian cultural heritage. The older generation of cultural figures showed caution out of inertia, remembering that the repressive apparatus could cut rights or even take life for any manifestation of disobedience. After all, the corresponding models of behavior extended to younger generations as well" (Rudenko, n. d.).

The Museum of Theater, Music and Cinema Arts of Ukraine has gone through various names in its history. So, from 1926 it was the Ukrainian Theater Museum (managed by P. Rulin); from 1927, the museum was located on the territory of the Kyiv-Pechersk Reserve; since 1934 it is the State Museum of Theater Art of the Ukrainian SSR; from 1965 – the State Museum of Theater, Music and Cinema; from 2002 – modern name Museum of Theater, Music and Cinema Arts of Ukraine.

It included the House-Museum of M. Lysenko and the Apartment Museum of P. Saksaganskyi as memorial departments (now the Museum includes the departments of Outstanding Figures of Ukrainian Culture Lesya Ukrainka, M. Lysenko, P. Saksaganskyi, and M. Starytskyi).

The Museum-apartment (since 1989) of M. Zankovetska and the Museum-apartment of V. S. Kosenko operate on the basis of the Museum (from 2009).

At the beginning of the 1980s, a unique in terms of content and artistic design permanent exhibition "Theatrical Art of Ukraine" was created (author A. Drak, design under the direction of V. Baturin).

Currently, the Museum of Theater, Music and Cinema Arts of Ukraine has a collection of about 260,000 items. Among the most valuable exhibits are the dolls and boxes of the Ukrainian puppet theater "Vertep" from the end of the 18th – beginning of the 19th century, theater posters and programs (from 1816), memorial material and documentary archives of prominent figures of Ukrainian theater and musical culture M. Zankovetska, M. Kropyvnytskyi, M. Starytskyi, M. Sadovskyi, P. Saksaganskyi, I. Karpenko-Karyi, M. Lysenko, M. Romanov, M. Lytvynenko-Wolgemit, Z. Gaidai, M. Smolych.

The fund of works by theater and film artists includes the works of O. Ekster, A. Petrytskyi, and F. Nirod, O. Khvostenko-Khvostov, V. Meller, M. Drak, A. Volnenko.

The fund of sheet music manuscripts consists of the autographs of M. Lysenko, M. Arkas, L. Revutsky, S. Lyudkevich, and A. Shtogarenko. The Museum has a large collection of photographs and negatives, a collection of works of fine art, photos and film documents. The specialized library has about 30,000 books and periodicals.

The main areas of activity are stock (stocking, accounting and storage), scientific research, exhibition and educational. Among the most important exhibitions are "Living Strings of Ukraine" (1990), "The Man Who Was a Theater. Les Kurbas". "Danylo Leader and modern Ukrainian scenography" (both – 1992), "B. Lyatoshynskyi" (1995), "Poet and philosopher of the Ukrainian stage. S. Danchenko". "Prophet in his homeland", "Camerton of the Ukrainian soul" (all – 2012), "Artistic life of Kyiv of the 20th century. in the relics of the museum collection (2013), "Both the dead, and the living, and the unborn...", "ART – resistance to the occupation" (Ukrainian artists for the fighters of the anti-terrorist operation in the East of Ukraine; both – 2014), "Cinematic universe of Yuriy Illenko and Ivan Mykolaichuk", "Ukrainian kinogenesis – (both – 2016), "Kurbas in Kyiv" (2017).

The museum participated in the exhibition project of the Ukrainian Museum in New York (USA) "Boris Kosarev: Kharkiv modernism 1915–1931" (2011–2012), the All-Ukrainian inter-museum exhibition project "Grand and great" (Kyiv, 2013). In 2015, an exhibition was exhibited that widely demonstrated the museum collection "Staging of the Ukrainian avant-garde 1910–1920" in the Ukrainian Museum in New York.

The album "Anatol Petrytskyi. Theatrical outfits and decorations" (Kyiv; Lviv, 2012) was published on the materials of the museum collection together with the Institute of Collecting Ukrainian Art Monuments at the National Academy of Sciences. Scientific readings "M. Zankovetska and her era" are held annually in the Museum of M. Zankovetska.

Today, the Museum of Theater, Music and Cinema Arts of Ukraine conducts art history research on the basis of stock collections, organizes scientific conferences (Makaryk, 2004, p. 199; Fowler, 2018; Kovalenko, 2019). It, like many other theater,

film and music museums, is characterized by some common problems and features. Let's analyze them in more detail.

The challenges faced by theater museums, film museums and music museums in the course of their activities have common features and may vary depending on the specific situation and context. However, some of the main common challenges theater museums may face include the following (Baker, Istvandy, & Nowak, 2020; Leeson & Núñez Martín, 2020; Fabrizi, 2023).

Preservation and conservation. Theater, film and music museums have a great responsibility to preserve valuable artifacts and materials. Preservation issues include the conservation, restoration, cataloging and proper storage of objects from collections. Museums, especially those with large collections of artefacts, musical instruments and props, face preservation and conservation challenges. Keeping these items in good condition can be a challenge as they are subject to wear, discoloration and other damage. Climatic conditions, relation to light, humidity and other factors can harm valuable exhibits, which requires constant monitoring and conservation measures.

Organization of exhibitions and collections. These museums typically have a wide range of exhibits and collections that reflect the history, development, and influence of theater, music, and film. These may include artifacts, costumes, props, musical instruments, manuscripts, posters, photographs, and other items related to these arts. Organizing exhibitions in such museums can be a challenge. It is necessary to decide how to present the collection so that it is accessible and interesting for visitors. Updating exhibits and installing new interactive technologies can be complex and require significant financial costs. There may also be questions about space, lighting and other aspects of exhibition design.

Expertise and research. Many of these museums have expertise in theatre, music and film. They conduct research, study historical aspects, curation, conservation and other aspects of these arts. They can be active participants in scientific research and publications in the relevant fields.

Financing. Many theater, film, and music museums depend on funding from public sources, grants, or private sponsors for contributions and attendance. However, funding may be irregular or insufficient, which may limit their ability to preserve, restore, and expand their collections, as well as to conduct educational and cultural activities.

Audience engagement. Attracting and retaining an audience is an important task for museums. However, the attractiveness of the museum experience for different age groups and categories of visitors can be a problem. Insufficient engagement with young people, unavailable adaptations for people with special needs, or limited accessibility for different social groups can affect the dissemination of the museum experience.

Education and programs for the public. Many theater, music, and film museums offer educational programs, lectures, workshops, concerts, film screenings, and other events for the public. These programs aim to promote, educate and engage audiences in these arts, as well as broaden cultural understanding and awareness. The appeal and educational programs of theater, film, and music museums are key to engaging the public. Developing innovative educational programs, conducting lectures, master

classes and interacting with schools and universities can help attract new audiences and engage young people.

Cooperation and sharing. Theater, music and film museums often collaborate with other museums, institutions, artists and organizations to create joint exhibitions, projects and events. They can participate in international exchange programs that help promote culture and art in different countries.

Accessibility. Ensuring physical and information accessibility for all visitors is an important aspect of theater museums. This includes creating accessible routes, lifts, audio guides for people with special needs and other measures to ensure equal opportunity for all visitors.

Technologies. Many museums use modern technologies to increase the number of visitors and improve the quality of their perception of museum collections. This may include the use of virtual reality, multimedia installations, interactive displays, audio guides, mobile applications and other innovative solutions to engage visitors and provide a more interactive experience. However, dependence on technology can also become a problem, especially in case of unstable internet connection, technical problems or high costs of supporting technological solutions.

These challenges may differ for each specific theater museum depending on its size, financial resources, location, and other factors. Their features may vary among theater, music, and film museums, depending on their resources, scale, and specialization. However, solutions to these challenges may include working with conservation professionals, attracting grants and sponsors, developing educational programs, and using new technologies to improve visitor audience engagement.

Conclusions.

Despite its relevance, the topic has not received adequate coverage in Soviet and modern Ukrainian historiography. Important aspects of the history and activity of theater museums, film museums, and music museums remain outside the attention of researchers, in particular: the causes of their emergence, regularities and factors of their development; formation stages; areas of activity; relationship with science and education. In addition, theater museums, film and music museums have never been studied as a separate profile group. Taking into account these aspects requires a further comprehensive study of the raised problem.

At the end of the 20th century – at the beginning of the 21st century, the employees of the Museum of Theater, Music and Cinema Arts of Ukraine reached a high level in its construction and development: the structure of the Museum was expanded by the departments of music, Ukrainian folk musical instruments, cinema; the memorial Museum-apartment of M. Zankovetska was opened, which contributed to solving the main problem – obtaining service and exhibition premises. Obtaining the proper conditions for further functioning made it possible to present the achievements of the representatives of the "Shooteed Revival" era in a new way and to lay the foundations for the spiritual revival of the 1990s, which manifested itself in the activation of the Museum's activities to honor the bright personalities of the Ukrainian sixties period.

Over the 100 years of its existence, the Museum of Theater, Music and Cinema Arts of Ukraine has undergone many changes and expanded its collection. It has become a center for the preservation and study of valuable artifacts, documents, costumes, musical instruments and other items related to Ukrainian theatrical, musical and cinematographic history.

The 100th anniversary of the Museum of Theater, Music and Cinema Arts of Ukraine is an important event that demonstrates the significant contribution of the museum to the preservation and promotion of the cultural heritage of Ukraine in the field of theatrical, musical and cinematic art.

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**Історія створення, становлення та розвитку Музею театрального,
музичного та кіномистецтва України**

***Анотація.** Авторами проаналізовано етапи створення, становлення, розвитку та сучасної діяльності Музею театрального, музичного та кіномистецтва України, який є єдиним в Україні за своєю спеціалізацією. Цей музей має славу на імена і події історії. Широко знаний в Україні та за її межами своїми постійно діючими експозиціями та пересувними виставками, створеними на унікальних експонатах з історії театру, музики, кіно. Зібрана за час існування – з 1923 р. – велика і багатогранна колекція пам'яток з історії розвитку мистецтв, яка постійно поповнюється новими матеріалами, є підґрунтям для науково-дослідної, науково-консультативної, експозиційно-виставкової роботи, багатим джерелом для популяризації здобутків національного театру, музики і кіно. У статті наголошується, що театральні музеї, музеї кіно та музики є невід'ємною складовою розвитку світової культури. Вони виникли, розвивалися і сформувалися в окрему типологічну групу музеїв мистецького профілю. Неповторність кожного театрального музею визначали стаціонарні експозиції та тимчасові виставки, які були основною сферою функціонування і формою використання та популяризації опрацьованих фондів. Відтворюючи явища та події театральної спадщини, експозиції і виставки унаочнювали найвизначніші надбання як минулого, так і сучасного театру та театрознавчої науки мовою музейних експонатів. Дослідження і аналіз історичного досвіду експозиційної і виставкової діяльності театральних музеїв, музеїв кіно та музики, матиме важливе значення для об'єктивної оцінки позитивних і негативних наслідків впливу національно-культурних процесів на їх функціонування і розвиток. Проблеми з якими стикаються театральні музеї, музеї кіно та музеї музики у ході своєї діяльності, мають загальні спільні риси та можуть варіюватися в залежності від конкретної ситуації та контексту. У статті здійснено аналіз характерних проблем та особливостей, з якими стикаються музеї театру, кіно та музики у своїй діяльності. У статті показано, що ці проблеми можуть відрізнятися у кожного конкретного театрального музею в залежності від його розміру, фінансових ресурсів, місцезнаходження та інших факторів. Їх*

особливості можуть варіюватися у різних музеях театального, музичного та кіномистецтва, в залежності від їхніх ресурсів, масштабів та спеціалізації. Проте, шляхи вирішення цих проблем можуть включати співпрацю зі спеціалістами з консервації, повернення грантів та спонсорів, розвиток освітніх програм та використання новітніх технологій для покращення залучення аудиторії відвідувачів.

Ключові слова: музеологія; театральні музеї; музеї кіно; музичні музеї; Лесь Курбас; Петро Рулін

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The activities of scientist agronomist S. M. Bogoyavlenskyy towards the establishment and development of the Kyiv Station for testing agricultural machines and tools (1901–1916)

Abstract. *The aim of the article is to reconstruct the course of events and facts of scientist agronomist Serhiy Mykolayovych Bogoyavlenskyy's activity for the benefit of the development of agricultural science in Ukrainian lands, especially regarding the establishment and development of the Kyiv station for testing agricultural machines and tools during 1914–1916 based on the "personal files" found in the archives. Scientific novelty of the article lies in the fact that it examines information about one of the closest assistants of Professor K. G. Schindler in such a difficult, from an organizational point of view, matter of expanding the activities of the mentioned station. The "personal files" of the agronomist S. M. Bogoyavlenskyy were found and analyzed for the first time, which made it possible to outline his contribution not only to the establishment and development of the station, but also to find out his creative achievements in the field of development of agricultural mechanics and machine science. The significant creative contribution of S. M. Bogoyavlenskyy to the activities of the first station for testing agricultural machines and tools in Europe during 1901–1916, as well as his professional political contribution to the preservation of its potential in 1911–1916 as an assistant of the director – first its founder Professor K. G. Schindler, and then – Professor P. R. Sliozkin. It was established that it was S. M. Bogoyavlenskyy at the initial stage of the Station's activity who was entrusted with the task of implementing the organizational plan developed by K. G. Schindler for the introduction of field management of the institution and the construction of premises. The participation of the scientist in carrying out appropriate tests of technical tools was foreseen not only for the needs of the educational process, but also for research and production purposes throughout the territory of the European part of Tsarist Russia and, first of all, in the Ukrainian provinces. We note the role of S. M. Bogoyavlenskyy in conducting experiments in field and laboratory conditions on*



soil cultivation, sowing, plant care and harvesting, as well as in the development of appropriate methods and the manufacture of devices for testing agricultural tools. In addition, he is credited with the preparation and printing of the first issue of "News of the Testing Station for Agricultural Machines and Tools at the Kyiv Polytechnic Institute" (1907). The scientist conducted practical sessions with KPI students on researching agricultural machines. The article documents for the first time the fact that S. M. Bogoyavlenskyy headed the Station immediately after K. G. Schindler was dismissed in 1911–1912. The fate of the scientist agronomist after 1916 remains unknown.

Keywords: S. M. Bogoyavlenskyy; K. G. Schindler; P. R. Sliozkin; Station for testing agricultural machines and tools; Kyiv Polytechnic Institute

Formulation of the problem.

With this publication, I return the figure and, especially, the creative achievements of an extraordinary scientist, educator and organizer of the system for testing agricultural machines to the pantheons of the history of the current National Technical University of Ukraine "Ihor Sikorsky Kyiv Polytechnic Institute" (KPI) and the National University of Life and Environmental Sciences of Ukraine, which have their 125th anniversary from the day of creation celebrated at the state level this year. It was S. M. Bogoyavlenskyy who, first of all, practically and methodically provided an agronomic world class exclusive in the activities of the Kyiv station for testing agricultural machines and tools at the KPI, at first, during 1901–1911, and did everything possible to preserve its potential in 1912–1916. The relevance of this topic, among other things, is due to the need to highlight certain trends in the development of native agricultural machinery.

Literature review.

Researchers have proven the outstanding generative role of Professor K. G. Schindler (1869–1940) in the emergence of the first Station for testing agricultural machines and agronomic tools in Europe at the Kyiv Polytechnic Institute of Emperor Alexander II (now the National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute") in 1900 (Vovk, 1927; Vasilenko, Baraban, & Koval, 1988; Vasilenko, Pogorelyj, & Vojtyuk, 1998; Derkach, 2011). The author of the article also contributed to relevant historical research, primarily through a contextual examination of the life and creative achievements of this Swiss subject (Verhunov, 2022; Verhunov, 2019). Along with this, the information about the role of the closest assistant of K. G. Schindler in such a difficult, from an organizational point of view, matter of conducting full-fledged activities of the station remains practically unexplored. As we managed to find out, according to the reports of the KPI in 1899–1911 (the time K. G. Schindler worked at this educational institution), first of all, through the printed publications "Personal staff of the Kyiv Polytechnic Institute of Emperor Alexander II", officially there are three such assistants who were full-time employees: S. M. Bogoyavlenskyy, M. M. Kagan and O. O. Khokhryakov. Available information about one of them: M. M. Kagan is systematized in general terms

(Verhunov, 2022). However, according to archival materials, the first among them was the agronomist Serhiy Mykolayovych Bogoyavlenskyy. He worked at the Kyiv Station for Testing Agricultural Machines and Tools from 1901 to 1916. In a special study dedicated to the world-renowned agricultural scientist Professor P. R. Sliozkin (1862–1927), I proved that after the resignation of Professor K. G. Schindler, it was he who headed the Kyiv station for testing agricultural machines and tools (Verhunov, 2019). During 1911–1916, as with the previous manager, S. M. Bogoyavlenskyy was appointed as his assistant, and in the event of a business trip, as the head of the Station. Nevertheless, in the modern history of the KPI, as well as the National University of Life and Environmental Sciences of Ukraine, which became the legal successor of the agricultural department of the KPI, there are no biographical information and references to the creative works of this employee (Kyivskyi politekhnichni i Kyivskyi silskohospodarskyi instytuty, 1923; Bieliakov, Vasylenko, Vilkov, & Havrysh, 1995). They are more descriptive about his studies at the institution (Khoto ye khto, 1998) and are quite limited about his achievements in the field of agricultural mechanics and mechanical engineering. I was one of the first in the recent history of Ukraine to mention the scientific achievements of S. M. Bogoyavlenskyy in my monograph “Professor Sliozkin Petro Radionovych (1862–1927)” (Verhunov, 2007, p. 98). I did the same in a special brochure in the form of a scientific report on the occasion of the 150th anniversary of Professor K. G. Schindler regarding the participation of S. M. Bogoyavlenskyy as a member of the expert commission of competitive plow tests in 1904 (Verhunov, 2019, p. 21). A generalized biography of the scientist is also presented in the materials of the conference (Verhunov, 2023).

Currently, it was possible to find his “Personal Files” in the State Archives of Kyiv: one – as an employee of KPI, the second – among those students who did not graduate from this educational institution. The latter is actually being introduced into scientific circulation for the first time. The absence of the “Formular list” in these files indicates that it, together with other documents for the period 1901–1911, was sent to the Department of Agriculture in connection with the transfer of S. M. Bogoyavlenskyy to work in this department. Both found “Files” made it possible to reconstruct the course of events and the facts of his actions for the benefit of the development of agricultural science and education in Ukrainian lands, especially in relation to little-studied pages in the activities of the Kyiv station for testing agricultural machines and tools during 1911–1916. There is information that during 1911–1914, its work “...was largely curtailed...”, and “...from 1914 to 1925” it “...ceased completely” (Vovk, 1927).

Research methodology.

The research methodology is based on the author's use of methods of historical-scientific analysis and systematization, which made it possible to critically approach the described phenomena of the scientist's biography and show disparate biographical facts with their internal relationship. The biographical method became key in the article. In particular, we used such a form as “biography-contextualization”, which emphasizes the presence of various contexts – intellectual, educational, social – that

outlined the external contours of the life of the scientist, educator and organizer of the agricultural machines testing system S. M. Bogoyavlenskyy.

Results and discussion.

S. M. Bogoyavlenskyy was born on October 9, 1876 in the Kirillovsky District of the Novgorod Province in the family of an honorary citizen (Bogoyavlenskij Sergej Nikolaevich, 1908). According to other information, namely “Metric Certificate No. 22” dated October 28, 1876 (State Archive of the City of Kyiv. F.361, op. 60, file 34: Bogoyavlenskyy S. N. Ark. 3). He received secondary special education with a diploma of the II degree No. 173 of September 06, 1899 (State archive of the city of Kyiv. F. 361, op. 60, file 34: Bogoyavlenskyy S. N. Ark. 3) and the title of academic agronomist after graduation from Kharkiv Secondary Agricultural School (now Kharkiv Biotechnology University). Somewhere during this period, the creative destinies of S. M. Bogoyavlenskyy and K. G. Schindler intersected, when the latter worked as a laboratory assistant at the Station for Testing Agricultural Machines and Tools at the Kharkiv Institute of Technology of Emperor Alexander III (now the National Technical University “Kharkiv Polytechnic Institute”) during 1898–1899. Enrollment among the soldiers of the militia of the 2nd category of the draft of 1899 (certificate No. 4687 dated December 15, 1899), according to the pass issued by Mariupol for military service (State archive of Kyiv. F.18, op. 1-a, file 467. "Serhiy Mykolayovych Bogoyavlenskyy". Ark. 3), proves the fact that S. M. Bogoyavlenskyy worked for a short time in his specialty after graduating from school in this region.

After moving to Kyiv and opening, in accordance with the decisions of the joint meeting of the agricultural and chemical departments in 1900, and then the Council of the KPI in April 1900, the Kyiv station for testing agricultural machines and tools, and also for the needs of organizing the educational training of specialists at the agricultural and mechanical departments of the KPI, K. G. Schindler invited S. M. Bogoyavlenskyy to the post of junior laboratory assistant (outside the staff) at the department of agricultural machines and tools from August 1901 (Bogoyavlenskij Sergej Nikolaevich, 1908, p. 35). Although there is a document which shows that S. M. Bogoyavlenskyy was enrolled in this position as early as March 31, 1901 (State Archive of the city of Kyiv. F.361, op. 60, file 34: Bogoyavlenskyy S. N. Ark. 19). By the way, the position of head of the station's economy - junior laboratory technician of the “... Department of Agricultural Engineering and Mechanical Science...”, along with the position of senior laboratory technician, was provided for by the project of the organization of the Testing Station of Agricultural Machines and Tools at the Kyiv Polytechnic Institute of Emperor Alexander II on March 18, 1900, proposed by Professor K. G. Schindler and was confirmed for introduction by the Council of the KPI (1900–1901. *Izvestiya Stancii...*, 1907, p. 10).

The opening of the Station, and over time, the demand for the results of its work, should be considered as an element of a well-thought-out state policy regarding the development of agricultural machinery in the country. First of all, we are talking about the regulation of the customs policy regarding the import of this type of products from abroad. Despite the constant contradictions between farmers and machine builders, the

state, having passed three stages: the first - duty-free until 1884; the second - customs for all products from abroad during 1884–1898; the third – selective regarding certain complex agricultural machines and tools, created favorable conditions under which “agricultural construction in Russia occupied a special place among other branches of industry...” and “...did not experience any crisis and took a giant step forward in its development” (Otchet o deyatel'nosti..., 1913, p. 2). Thus, through the customs policy, a rather successful innovative project was launched with the aim of abandoning the import of agricultural machines and tools from abroad. For these needs, Professor K. G. Schindler and the Council of the KPI made a timely decision to open the Kyiv station for testing agricultural machines and tools. It was S. M. Bogoyavlenskyy at the initial stage of its activity who was entrusted with the task of implementing the organizational plan developed by K. G. Schindler for the introduction, first of all, of field management of the institution and the construction of premises. It is clear that his duties also included participation in appropriate tests of technical agricultural tools not only for the needs of the educational process, but also for research and production purposes throughout the territory of the European part of Tsarist Russia and, first of all, in the Ukrainian provinces.

Under the leadership of Professor K. G. Schindler, his assistant directly implemented the organization of four crop rotations and supervised the construction of five economic premises for needs of the experimental field, as well as a five-room laboratory on 30 acres of land 3 *versts* from the main building of the KPI in the direction of the village of Borshchagivka along the Brest-Lytovsk highway (1900–1901 gg. *Izvestiya Stancii...*, 1907, p. 4). It is clear that his role and responsibility for conducting stationary field and laboratory experiments on soil cultivation, sowing, plant care and harvesting with his direct participation was equally important. In this regard, he closely cooperates with the department of private agriculture (plant production) of KPI headed by Professor P. R. Sliozkin. Also, S. M. Bogoyavlenskyy participated in the development of appropriate methods and the manufacture of devices for testing agricultural tools and, of course, in the preparation of the corresponding “Reports”. We are talking about the results of competitions for testing agricultural tools, starting from the summer of 1902 in the “Sukhyi Yar” economy of the estate of Countess M. E. Branytska near the city of Bila Tserkva (Schindler, K. G., 1904). The materials of the plow test competition held by the Kharkiv Agricultural Society on September 10-22, 1905 in the Sharov economy of the descendants of L. E. Kenning in the Akhtyr district of the Kharkiv province, testify to the official position of S. M. Bogoyavlenskyy – assistant of the department of agricultural machines and tools of the KPI and assistant manager of the Kyiv station for testing agricultural machines and tools. Although, as evidenced by his “Personal file” in the KPI, the position had a title – manager of the economy of the Kyiv station for testing agricultural machines and tools (State archive of the city of Kyiv. F. 361, op. 60, file 34: Bogoyavlenskyy, S. N. Ark. 5). At least when submitting the necessary documents to obtain “...perpetual passport book No. 1036 dated August 5, 1905...”, issued by the Kyiv police, he indicates exactly this position (State archive of the city of Kyiv. F. 18, op 1-a, file 467. "Bogoyavlenskyy Serhiy Mykolayovych". Sheet 3).

Unfortunately, there is no copy of this passport in both archival “Files” of S. M. Bogoyavlenskyy, which, due to the information included in it, would be useful in the reconstruction of his biography. It is known that the passport system in the Russian Empire was finally formed after the adoption of the “Regulations on Types of Residence” in 1894 (although it was implemented from 1765–1795) (Olejnik, 2007, p. 21). According to this document, everyone who left their place of residence for a distance of more than 50 *versts* and for a period of more than 6 months should have passports. As a manifestation of democracy in 1903, all passporting was abolished, with the exception of those working at strategic facilities. The Russo-Japanese war proved that a huge segment of the population had no surnames at all, not to mention the presence of some kind of record for the needs of mobilization. As a result, continuous passporting was again introduced. That is why S. M. Bogoyavlenskyy was forced to submit documents for obtaining a passport again.

With the active participation of S. M. Bogoyavlenskyy, the 88-page first issue of “News of the Testing Station of Agricultural Machines and Tools at the Kyiv Polytechnic Institute” was prepared and printed, which saw the light of day in 1907. By the way, this publication was the first “...on the territory of the Russian Empire for the needs of agricultural engineering and machine science, since the ‘News of the Bureau of Agricultural Mechanics’ of the Scientific Committee of the Head of Land Management and Agriculture began to be printed in St. Petersburg only in 1909” (Erk, 2004, p. 49). Given that the “News of the Testing Station of Agricultural Machines and Tools at the Kyiv Polytechnic Institute” was prepared for printing on March 18, 1902, other assistants were not able to participate in its preparation in 1900–1901. The publication clearly states that “... since the spring of 1901... the management of the economic part was entrusted to... agronomist S. M. Bogoyavlenskyy”, and “... the performance of the duties of a professor at the department of applied mechanics (for the department of agricultural machinery) to the mechanical engineer K. G. Schindler” as well as management duties (1900–1901 gg. *Izvestiya Stancii...*, 1907, p. 4). Together with the architect of the KPI V. O. Obremskyi, S. M. Bogoyavlenskyy took care of the construction work. As for the field work, in addition to the students of the fourth year of the agricultural department, candidate of natural sciences M. O. Zhdan-Pushkin, doctor O. I. Radkevich, and veterinarians O. M. Sukhanov and O. V. Teslenko took part in their implementation. This edition announced the release of the second edition of the “News” in early 1908, which contained the Station's report for 1902 and the results of its research with disc cultivators, beet and compound fodder planters, as well as mowers, reapers and baler reapers. But a separate edition was never printed.

Due to having only secondary special education, S. M. Bogoyavlenskyy could not apply for other official preferences and, accordingly, an increase in salary. For the scientific and educational environment in which he was, it could only be achieved by receiving the title of professor, or even better, an ordinary professor with a salary of 2,700 *krb*. In addition, there were preferences regarding promotion through the ranks of the civil service, provided for by the “Petrovian rank report”. The latter allowed the professor to reach even the fifth class or a valid state adviser and, most importantly,

granting the right to “personal nobility” (Bautin & Kazarezov, 2005, p. 281). All this gave additional funds and privileges, even in relation to the same pension.

The latter became too important not only because of problems with the S. M. Bogoyavlenskyy's wife health – Iuliania Ivanivna (State archive of the city of Kyiv. F. 361, op. 60, file 34: Bogoyavlenskyy S. N. Ark. 5), and, first of all, the eldest son – Oleksandr (1901) (State archive of the city of Kyiv. F.361, op. 60, file 34: Bogoyavlenskyy S. N. Ark. 9). They became even more significant with the birth of second son Volodymyr. By the way, according to the “Metric Certificate No. 12479” issued by the Kyiv Spiritual Consistory and sent to the KPI office by letter No. 839 dated March 27, 1913, the youngest son of S. M. Bogoyavlenskyy was born on this very day (State Archive of the City of Kyiv. F. 18, op.1-a, file 467. "Bogoyavlenskyy Serhiy Mykolayovych". Ark. 4). And the father's receipt confirming the receipt of the document was sent by the director of the KPI on April 2, 1913 by letter No. 1124 (State archive of the city of Kyiv. F. 18, op. 1-a, file 467. "Bohoyavlenskyy Serhiy Mykolayovych". Ark. 6). Troubles with the children's health became the basis for S. M. Bogoyavlenskyy's appeal to the director of the KPI for material assistance (Kyiv State Archive. F. 361, op.60, file 34: S. N. Bogoyavlenskyy Ark. 7). Therefore, it seems that it is no coincidence that in 1907 he enrolled into the agricultural department of the KPI. At the same time, he does everything possible to combine training with the management of the farm of the Kyiv station for testing agricultural machines and tools.

The basis for us to assert the successful operation of the Station is the constant growth of the authority of the institution, first of all, due to the steady increase in the number of students of the agricultural and mechanical department of KPI, who expressed a desire to prepare diploma theses based on the results of research and opportunities at the Station. Subsequently, S. M. Bogoyavlenskyy claimed that if in 1903 there were only 3 such students, then by 1914 there were 14, and the amount of people “working at the station in 1912” with various research problems reached 204 in total (Agricultural machine-building..., 1913). S. M. Bogoyavlenskyy took care of providing favorable opportunities for this together with the head of the Station. Although, as a result, his direct participation in various competitions for testing agricultural machinery decreased. At the same time, the number of practical classes in agricultural engineering increased. More than ten years of becoming responsible for the duties assigned to him, and also under the leadership of Professor K. G. Schindler, made S.M. Bogoyavlenskyy a recognized specialist in his field not only in the institution, but also in the country. According to “Relation” No. 24 dated Jnuary 03, 1911 of the Department of Agriculture of the Main Department of Land Management and Agriculture, he is appointed as a full-time specialist or specialist in testing agricultural machines and tools (State Archive of the City of Kyiv. F. 361, op.60, file 34: Bogoyavlenskyy SN Ark. 2). The corresponding recommendation was given by Professor K. G. Schindler, who in 1907 became a member of the Bureau of Agricultural Mechanics of the Scientific Committee of the Main Department of Land Management and Agriculture created in 1899 (Erk, 2004, p. 40–41).

A little later, namely on January 18, 1911, by the decision or “Journal of the Department of Agriculture” under No. 2545, S. M. Bogoyavlenskyy was seconded to

the disposal of the KPI “for improvement in the sciences” (State Archive of the City of Kyiv. F. 361, op. 60, file 34: Bogoyavlenskyy S. N. Ark. 3). The corresponding appeal addressed to the director of the KPI under No. 3055 was sent by the Department of Agriculture on January 21, 1911. In the same letter, its vice-director asked the director of the KPI to accept “...an oath of loyalty to the service with delivery to the Department of his sworn promise in execution of such” from S. M. Bogoyavlenskyy (State Archive of the city of Kyiv. F. 361, op. 60, file 34: Bogoyavlenskyy S. N. Ark. 2). Archpriest Prozorov conducted the relevant procedure on March 17, 1911, in the presence of the director of the KPI, state adviser, professor K. G. Dementiev (1864–1916) (Khoto ye khto, 1998, pp. 40–41). Taking what we call today the “oath of a public servant”, S. M. Bogoyavlenskyy promised before God and the Gospel to the All-Merciful Sovereign Emperor Mykola Alexandrovych and the Heir to the All-Russian Throne “...to serve faithfully and hypocritically, and to obey in everything, not sparing the stomach to the last drop of his blood...” (State Archive of the city of Kyiv. F. 361, op. 60, file 34: Bogoyavlenskyy S. N. Ark. 4). The very next day, the “Sworn Promise” with accompanying letter No. 1864 signed by the director and clerk of the Office and the Board of the KPI was sent to the Department of Agriculture. Why was there a delay in taking the oath? Most likely, it was due to the events at KPI, which led to the resignation of three deans of departments (faculties), including Professor K. G. Schindler, on February 4, 1911, due to the “Casso Case” (The resignation of professors..., 1911, p. 3). As a result, the institution lost 11 leading professors, “...who managed to make a name for themselves in science and were the best in managing the teaching business” (Kyivskyi politekhnichni i Kyivskyi silskohospodarskyi instytut, 1923, p. III).

S. M. Bogoyavlenskyy also had to decide, since a significant number of employees resigned in addition to the professors. As we managed to establish, among the latter was M. M. Kagan - another assistant of K. G. Schindler. The desired balance was achieved in a rather unexpected way, namely with the help of dismissed professors. They also “...recommended deputies, the vacant chairs were soon occupied by new forces” (Kyivskyi politekhnichni i Kyivskyi silskohospodarskyi instytut, 1923, p. III). There is every reason to claim that S. M. Bogoyavlenskyy's decision to stay was primarily made by Professor K. G. Schindler. Having weighed all the pros and cons, S.M. Bogoyavlenskyy decided to stay at KPI and actually headed the Station for testing agricultural machines and tools. Moreover, its new temporary head, Professor P. R. Slizokin, occupied other positions as well, namely he was the dean of the agricultural section and the head of the department of private agriculture (plant production); in the absence of the director, he headed the KPI. The appointment of P. R. Slizokin as the head of the Station for testing agricultural machines and tools in accordance with the decision of the KPI Council and the consent of the training department of the Ministry of Trade and Industry became logical. Since his predecessor was also the dean of the section and the head of the department. The experimental field at the Station was used, first of all, for the scientific and educational needs of the Department of Agriculture (Bread) headed by Professor P. R. Slizokin and the office of “Private Agriculture and Seed Science”. In addition, Petro Radionovich was a well-

known specialist in the use of agricultural machinery in agricultural production after the publication of the manual “Agronomist-trainee in the economy” (Slezkin, 1905) in 1905, had a secondary technical education after graduating from the Mechanical Department of the Moscow Real School in 1881. It should be added that since the beginning of the activity of the Station, P. R. Slizkin cooperated with it, first of all, with the research field, for the activities of which S. M. Bogoyavlenskyy was conscientiously responsible. The new manager also made every effort to ensure that S. M. Bogoyavlenskyy continued fulfilling his duties in the future.

There is every reason to say that significant problems with the health of his children and wife, the lack of his own housing did not give S. M. Bogoyavlenskyy opportunities for other employment. Moreover, he received a fairly decent salary for his status from the Department of Agriculture, which made it difficult to freely choose a place of work. Confirmation of the constant problems with the health of family members is the “Petition” of S. M. Bogoyavlenskyy to the director of the KPI dated May 18, 1911. In it, he asks to issue an “Identity Certificate” for his wife I. I. Bogoyavlenskyy and “... two children: boys 10 and 7 years old” for “...health improvement in one of the country areas of the Kyiv province” (State archive of the city of Kyiv. F. 361, op.60, file 34: Bogoyavlenskyy S. N. Ark. 5). On the same day, it was issued for the period from “... May 18 to September 1, 1911” with the order of the assistant manager of the Station for Testing Agricultural Machines and Tools – to provide all kinds of assistance to Iuliania Ivanovna Bogoyavlenskyy to receive “... free passage and all kinds of assistance in her legal requirements” (State archive of the city of Kyiv. F. 361, op. 60, file 34: Bogoyavlenskyy S. N. Ark. 6). His signature was certified by the director of KPI. By the way, the basis for obtaining a “Certificate” for treatment was “Certificate” No. 43 dated May 08, 1911 of KPI doctor V. Polinov about the dangerous health condition of his son Oleksandr, who developed “...lung tuberculosis...” after suffering “... in December 1909... catarrhal inflammation of the lungs four times and several times bronchitis, and in April that year, suffered from diphtheria, which led to a weakening of the body...” (State archive of the city of Kyiv. F. 361, op. 60, file 34: Bogoyavlenskyy S. N. Ark. 8). As a result, the doctor recommended sending the child to the Southern coast of Crimea for the whole summer. Not having the appropriate financial capabilities, S. M. Bogoyavlenskyy, adding the opinion of the institute doctor, turned to the director of the KPI with a request “...to issue monetary assistance in the amount of 150 *krb*” (State archive of the city of Kyiv. F. 361, op. 60, file 34: Bogoyavlenskyy S. N. Ark. 9). It is clear that a family of three could not afford to go to Crimea with such funds. Nevertheless, the son's health was improved.

A difficult situation with scientific work arose at the Station after the resignation of Professor K. G. Schindler. The institution lost its generating sequence, and most importantly, its significance for practical and theoretical issues of testing agricultural machines and tools. This was confirmed at the national level during the speech of S. M. Bogoyavlenskyy at the meeting of the subsection of agricultural machine building of the Second All-Russian Congress of Workers of Mining, Metallurgy and Machine Building, which took place on April 17–24, 1913 in St. Petersburg. If from

1901 the spectrum of research into agricultural machinery was systematically expanded from balers to beet planters, harrows, disk cultivators, plows, etc. to their individual working bodies, then from 1912 a gradual contraction began. As a result, related research, which was directly carried out by S. M. Bogoyavlenskyy, on issues of agrophysics of the soil in connection with its cultivation, as well as the determination of grain losses during various methods of harvesting, also stopped (Agricultural machine-building station..., 1913, p. 285). And since the first experiments were the object of S. M. Bogoyavlenskyy's diploma project as a student of the agricultural department of KPI, the issues of its defence remained unresolved.

Confirmation was found that since 1912, the capabilities of the Kyiv Station for testing agricultural machines and tools were practically not used. Thanks to S. M. Bogoyavlenskyy, its experimental field actually fully functioned, "...divided into regular squares of 40x69 square s." (Verhunov, 2019, p. 225). It supported four crop rotations: three-four-six and eight-field, where S. M. Bogoyavlenskyy conducted certain researches together with students. But practically everything fell apart with the beginning of the First World (European) War, declared by Germany on July 19, 1914. In order to organize proper resistance to the enemy by concentrating the efforts of the regions on July 30, 1914, the All-Russian Zemstvo Union was created, which "...united the Zemstvo institutions of 41 provinces" (Verstiuk, Dziuba, & Repryntsev, 2005). Kyiv province, along with others, was in the area of action of the South-Western Front. Nevertheless, life in the rear continued and even in matters of conducting contests for testing agricultural machinery. The front needed more quantitative and, most importantly, high-quality food. Thus, on May 07, 1915, the head of the Podilsk Society of Agriculture and Agricultural Industry (PSAAI) A. S. Urbansky (1873–1950), together with secretary O. P. Rusanovsky (1883–1925), addressed the director of the KPI with letter No. 1012 with a request to send "...Professor Serhiy Mykolayovych Bogoyavlenskyy as the technical manager of the competition...", which was organized by this creative association (which traces its history since 1898) in the city of Vinnytsia on May 26-27, 1915, to test "...domestic plows" (State archives of the city of Kyiv F. 361, op. 60, file 34: Bogoyavlenskyy S. N. Ark. 11 a). It should be emphasized that, first of all, the mechanical department (created in 1902) of the PSAAI, starting from the spring of 1903 with a competition for a beet thinning machine in the village of Kordelivtsi of the Vinnytsia district systematically and annually held various events for testing agricultural machines, starting from 1899. At the same time, it repeatedly turned to the Kyiv station for testing agricultural machines and tools for various kinds of technical and methodical help. The object of the tests was mostly sugar beet culture, namely mechanisms for its thinning and digging and, especially, tools for loosening the soil (Lyubanskij, 1911, p. 16). With the beginning of the World War I, the mechanical department of the PSAAI under the leadership of E. I. Malakhovskyy joined the scientific work. Among other things, he justifies the proposal to the government to "...reduce the duty on agricultural machines and tools from America and England..." as "...a temporary measure due to the acute need for them in the market" (Kolesnyk, 2007, p. 70). Taking into account the import of a large number of plows from these countries, the Board of the society decided to investigate which domestic

analogues are not inferior to them and which factories are capable of producing them in large quantities. The mandatory condition was not to give in to the corresponding German products in terms of characteristics. First of all, we were talking about single-plow plows. The board decided to hold the competition during the regular annual meeting of PSAI members. Since representatives of all the factories of the Russian Empire were invited to it, the head of the competition commission also appointed a representative from a long-standing reliable partner – the Kyiv station for testing agricultural machines and tools.

Letter of approval No. 1185 dated May 19, 1915, in accordance with the decision of the KPI Council dated May 16, 1915 and signed by the director of the KPI Professor I. D. Zhukov (1860-1923), is received by S. M. Bogoyavlenskyy (Khoto ye khto, 1998, p. 50). Letter No.1186, similar in content, was also sent to the head of the Podilsk Society of Agriculture and Agricultural Industry (State Archive of the City of Kyiv. F.361, op.60, file 34: Bogoyavlenskyy S. N. Ark. 12). As a responsible specialist in his field, on May 22, 1915, S. M. Bogoyavlenskyy, as the assistant manager of the Kyiv station for testing agricultural machines and tools, appealed with the “Report” to the dean of the agricultural department and at the same time the station manager, Professor P. R. Sliozkin, to grant him a leave of absence “...to perform preparatory works for the competition on May 23, 24, 25–28” (State Archive of Kyiv. F. 361, op.60, file 34: Bogoyavlenskyy S. N. Ark. 13). The next day, the corresponding approval was received. However, there are reasons to assert that the competition did not take place, since the complete evacuation of enterprises began after the front approached the city of Vinnytsia due to the retreat of Russian troops from Galicia and Poland in April 1915 (Verstiuk, Dziuba, & Repryntsev, 2005).

After returning from Vinnytsia, S. M. Bogoyavlenskyy, in addition to the experimental field, almost completely immersed himself in the affairs of the Station, which was constantly experiencing various problems since the beginning of the war. They reached a threatening state in 1915 when “...a threat to Kyiv...” emerged and the KPI “...received an order to evacuate to Rostov” due to the offensive of German and Austrian troops (Kyivskyi politekhnichniy i Kyivskyi silskohospodarskyi instytut, 1923, p. IV). As a result, in the fall of 1915, the Kyiv station for testing agricultural machines and tools was handed over to the Military-Industrial Committee, while the position of the manager was reduced. That is why S. M. Bogoyavlenskyy agreed to the proposal of the Committee of the South-Western Front of the All-Russian Zemstvo Union “...to join the service in one of the departments of the committee” (State archive of the city of Kyiv. F.361, op. 60, file 34: Bogoyavlenskyy S. N. Ark. 15). After the meeting of the Station Committee on November 13, 1915, when it was finally clarified that from the spring of 1916, practical classes with students would not take place, since the horses were transferred to the Experimental Estate (mansion) “Zatyshne” in the town of Bobrovytsia of the Chernihivska province, and fodder – to the KPI Livestock Farm, S. M. Bogoyavlenskyy agrees to head the department of preservation and exploitation of horses of the All-Russian Zemsky Union. This decision was not accidental, since according to the resolution of the Military-Industrial Committee, the station estate was adapted for a gas plant for “...production of suffocating gases...”

(Grebenchuk, 1923, p. 225). Although before that, as early as 1914, relevant special experiments were conducted for almost a year, "...throwing all the assets of the station outside" (Kyivskiy politekhnichnyi i Kyivskiy silskohospodarskyi instytuty, 1923, p. 188). A document was found in the personal "File" stored in the Kyiv Regional State Archives among the archive files of employees of the Kyiv Polytechnic Institute of Emperor Alexander II of the Ministry of Trade and Industry, namely Professor P. R. Sliozkin, which once again proves the authority of S. M. Bogoyavlenskyy and respect from him (Slezkin, P., 1905). In the "Report" dated September 8, 1915, to the director of the KPI, Professor I. D. Zhukov, P. R. Sliozkin, who was leaving on a business trip to Saratov, asks to appoint "... the assistant manager S. M. Bogoyavlenskyy" in his place as the head of the farm at the Station for testing agricultural machines and tools together with the obligation to preserve "...the property of this institution, as well as the property of the experimental field..." and in connection with "... the transfer of the premises of the station for military purposes..." to allow him "... to live in my apartment until my return" (Verhunov, 2005, p. 93). The director of the institution, as well as the Board of the KPI, at their meeting on September 13, 1915, approved the request for the period from September 8 to November 05, 1915. After the management of the station passed into nominal status, which is confirmed by one of the authoritative students of Professor K. G. Schindler – the future corresponding member of the Academy of Sciences of the Ukrainian SSR L. P. Kramarenko (1881–1960), a well-known specialist in the theory and calculation of constructions of agricultural machines (Kramarenko, 2018, p. 291–192), S. M. Bogoyavlenskyy focuses his activities on "... preservation the horse population and in general on the application of all measures to eliminate in the future the so-called 'horse famine'" (State Archive of Kyiv. F.361, op. 60, file 34: Bogoyavlenskyy S. N. Ark. 15). In addition, according to the proposal of the manager of the Kyiv Treasury Chamber, which at that time was in charge of a significant amount of invested property of the city of Kyiv, he also took the position of manager of one of the investment firms. Under such circumstances, on June 7, 1916, he turned to the director of the KPI with a request to grant "...long-term leave ... and without salary" (State Archive of the city of Kyiv. F. 361, op. 60, file 34: Bogoyavlenskyy S. N. Ark. 16). In case of disagreement, he asked to be dismissed from work at the KPI with the provision of a "Certificate" about his stay at the KPI since March 1, 1901, conducting practical classes in agricultural mechanical engineering, as well as the issuance of "per diem" from September 1915, based not on the official salary calculation of 1,000 *krb* but "...from the sum of 1,600 *krb* (1000 *krb* salary + 600 *krb* for conducting practical classes) ..." (State Archive of the city of Kyiv. F. 361, op. 60, file 34: Bogoyavlenskyy S. N. Ark. 16). As an argument, he refers to the "explanation" on this matter of the Control Chamber dated May 23, 1916. And he also asked to compensate 224.45 *krb* for personal funds spent in 1915 for the needs of the Kyiv station for testing agricultural machines and tools. The relevant "Report" was submitted by S. M. Bogoyavlenskyy back on May 20, 1916. It was considered on May 30, 1916. The KPI Board decided to send a special appeal to the Kyiv Control Chamber to obtain the appropriate permission for payments "...from the amounts of the 1916 estimate of the agricultural department..." according to

“...calculations in the amount of 224 *krb* 45 *kop*” (State archive of the city of Kyiv. F. 361, op. 60, file 34: Bogoyavlenskyy S. N. Ark. 14–14a). Petition No. 1307 of May 31, 1916, signed by the director of the KPI, Professor I. D. Zhukov, was sent to the Kyiv control station. It seems that the daily allowances were paid, but the personal expenses were not. By the way, a certificate of employment at KPI has not been received either. Nevertheless, on June 8, 1916, the KPI issued order No. 23, according to which S. M. Bogoyavlenskyy was released from “... performing the duties of the head of the farm at the Station for testing agricultural machines and tools of the Kyiv Polytechnic Institute of Emperor Alexander II... from June 1 1916” (State Archive of Kyiv. F. 361, op. 60, file 34: Bogoyavlenskyy S. N. Ark. 17). Regarding the return of personal funds spent by S. M. Bogoyavlenskyy for the needs of the station, on August 20, 1916, the director of the KPI, in his new letter No. 1969, again due to “...failure to receive a response... to the results of the request...” sent on May 21, 1916 regarding S. M. Bogoyavlenskyy, asked to give consent to pay him 224 *krb* 45 *kop* (State archive of the city of Kyiv. F.361, op.60, file 34: Bogoyavlenskyy S. N. Ark. 18–19). However, it is not known for certain whether this request was granted.

S. M. Bogoyavlenskyy's dismissal from work at the KPI was connected, first of all, with his conscription for active military service. This is confirmed by letter No. 17008 dated June 1, 1916 from the Deputy Director of the Department of Agriculture to the Director of the KPI with a request to hand over to S. M. Bogoyavlenskyy's “Certificate of Attendance for Military Service... No. 4687...” (State Archive of Kyiv. F. 18, op. 1-a, file 467. "Bogoyavlenskyy Serhiy Mykolayovych". Sheet 1). The director of the KPI informed the Department of Agriculture of the Ministry of Agriculture about the service of the summons to S. M. Bogoyavlenskyy by letter No. 3226 dated June 1, 1916 (State archive of the city of Kyiv. F. 18, op. 1-a, file 467. "Serhiy Bogoyavlenskyy Mykolayovych". Ark. 2). Even before this telegram, namely on May 21, 1916, S. M. Bogoyavlenskyy asked the director of the KPI “...to make an order to exclude him from the lists of students subject to the lottery on May 20, 1916” (State archive of the city of Kyiv. F. 18, op. 1-a, file 467. "Bohoyavlenskyi Serhiy Mykolayovych". Ark. 3). But in connection with the content of the statement, there may be other motives for dismissal from KPI! ...

As for the Station for Testing Agricultural Machines and Tools, it was headed by L. P. Kramarenko in mid-1916, who already began to give lectures at the Mechanical Faculty of KPI “From the Course of Agricultural Machine Building” in 1915 (Kramarenko, L. P., 1923, p. 188). Through his efforts, in the same year, the Military-Industrial Committee built a suitable building in the KPI manor, where all the possessions of the station were moved. Among other things, it was also about the exhibits of the Museum of Agricultural Machines and Tools of the Station, which was previously looked after by S. M. Bogoyavlenskyy.

After 1916, the creative fate of the assistant of professors K. G. Schindler and P. R. Sliozkin – S. M. Bogoyavlenskyy remains unknown. According to archival documents, he was alive on June 7, 1928. After all, on that day, S. M. Bogoyavlenskyy submits an application in the name of the rector of the KPI in the state language with a request to issue a “Certificate” that he worked at the institution “... at the machine

research station from March 1, 1901 to June 1, 1916, when he resigned from his post at his own request” (State Archive of the city of Kyiv. F. 361, op. 60, file 34: Bogoyavlenskyy S. N. Ark. 19). At the same time, he adds that he was an assistant to the head of the station Professor K.G. Schindler, and since 1912 performed the duties of its head. In addition, he conducted practical sessions with students on agricultural machinery research. By the way, all this information was confirmed in a separate statement by the world-renowned physicist and chemist, Academician of the Academy of Sciences of the Ukrainian SSR V. O. Plotnikov (1873–1947) (Khto ye khto, 1998, p. 105), with whom S. M. Bogoyavlenskyy collaborated in KPI, where he indicated that “I know Comrade Bogoyavlenskyy very well, for my part, I am asking you to grant his request” (State archive of the city of Kyiv. F. 361, op. 60, file 34: Bogoyavlenskyy S. N. Ark. 20). Currently, this is all documented information about S. M. Bogoyavlenskyy. It is known that he was in the USSR in 1928 and works as an agronomist, is engaged in the registration of a personal pension. It is possible that later he could become a figurehead in the political processes fabricated by the NKVD bodies, like, by the way, another assistant of Professor K. G. Schindler at the Kyiv station for testing agricultural machines and tools – M. M. Kagan. At least the surnames of both of them, in contrast to O. O. Khokhryakov, are not found among the other figures of the comprehensive guide “Science and scientific workers of the USSR”, published in Leningrad in 1928 (Nauka i nauchnye rabotniki SSSR, 1928), and among the working in scientific institutions and organizations of the USSR for 1930 (Naukovi ustanovy ta orhanizatsii USRR, 1930). The surname of S. M. Bogoyavlenskyy was not found among those repressed according to the fabricated NKVD trials of the “Prompartia” (Process Prompartii..., 1931) and “Union of the Liberation of Ukraine” (Spilka vyzvolennia Ukrainy..., 1930), as well as “Counter-revolutionary harmful organization in rural economy of Ukraine” (Marochko, V., 1998). It is not mentioned among the participants in the no less daring case of the “Ukrainian Branch of the Labor and Peasant Party” (Hryhoriev & Ocheretenko, 2010). This can only be confirmed by further archival searches, as, by the way, with regard to his creative output in the form of articles and popular scientific publications. I am sure that he was also an active participant in the development of new designs of agricultural machinery.

Conclusions.

Thus, the significant creative contribution of S. M. Bogoyavlenskyy to the activities of the first station for testing agricultural machines and tools in Europe during 1901–1916, and especially state-professional in preserving its potential in 1911–1916, as an assistant director – first to its founder Professor K. G. Schindler, and then to Professor P. R. Sliozkin, has been proven. It was established that it was S. M. Bogoyavlenskyy who was entrusted with the task of implementing the organizational plan developed by K. G. Schindler for the introduction of field management of the institution's experimental field and the construction of experimental premises at the initial stage of the Station's activity. The participation of the scientist in carrying out appropriate tests of technical means not only for the needs of the

educational process, but also for research and production purposes throughout the territory of the European part of Tsarist Russia and, first of all, in the Ukrainian provinces is also proven. We note the role of S. M. Bogoyavlenskyy in conducting experiments in field and laboratory conditions on soil cultivation, sowing, care for field plants and their collection, as well as in the development of appropriate methods and the manufacture of devices for testing agricultural tools. In addition, he is credited with the preparation and printing of the first issue of: *News of the Station for Testing Agricultural Machines and Tools at the Kyiv Polytechnic Institute*: (1907). The scientist conducted practical classes with students of the Kyiv Polytechnic Institute of Emperor Alexander II on researching agricultural machines, in his creative work he had a number of theoretical and methodological achievements in the field of agricultural mechanics and machine science, he repeatedly acted as an expert in competitive tests of agricultural machines and tools. Along with this, neither the biography nor the scientific heritage of S. M. Bogoyavlenskyy has currently been reconstructed and analyzed to the full extent, which actualizes the further search in this direction as well.

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Conflicts of interest.

The author declare no conflict of interest.

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Діяльність вченого агронома С. М. Богоявленського у напрямку становлення і розбудови київської станції по випробуванню сільськогосподарських машин і знарядь (1901–1916 рр.)

Анотація. Метою статті є реконструкція, на основі знайдених архівних «особових справ» ученого агронома Сергія Миколайовича Богоявленського, перебігу подій і фактів його діянь на благо розвитку аграрної науки на українських землях, особливо стосовно становлення і розбудови Київської станції по випробуванню сільськогосподарських машин і знарядь протягом 1901–1916 рр. Наукова новизна статті полягає в тому, що в ній досліджено інформацію про одного з найближчих помічників професора К. Г. Шиндлера в такій непростій, в організаційному відношенні, справі з розгортання діяльності зазначеної станції. Віднайдено і вперше проаналізовано «особисті справи» вченого агронома С. М. Богоявленського, що дало можливість окреслити його внесок не лише у становлення і розбудову станції, а й з'ясувати творчі здобутки на ниві розвитку землеробської механіки та машинознавства. Доведено значний творчий внесок С. М. Богоявленського в діяльність першої в Європі агрономічного напрямку Станції по випробуванню сільськогосподарських машин і знарядь при Київському політехнічному інституті протягом 1901–1916 рр. і по-державницьки професійного щодо збереження її потенціалу в 1911–1916 рр. як помічника завідувача – спочатку її фундатора професора К. Г. Шиндлера, а потім – професора П. Р. Сльозкіна. Встановлено, що саме на С. М. Богоявленського на початковому етапі діяльності Станції було покладено завдання реалізації розробленого К. Г. Шиндлером організаційного плану із запровадження польового господарства установи та будівництва приміщень. Передбачалася й участь ученого у здійсненні відповідних випробувань технічних засобів не лише для потреб освітнього процесу, а й для дослідницьких і виробничих цілей по всій території Європейської частини царської Росії і, насамперед, в українських губерніях. Відзначаємо роль С. М. Богоявленського у

проведенні в польових і лабораторних умовах дослідів з обробітку ґрунту, висіву, догляду за рослинами та їх збиранням, а також у розробленні відповідних методик та виготовленні приладів для випробування землеробських знарядь. Крім того, йому належить заслуга у підготовці та друці першого випуску «Вістей станції випробування землеробських машин і знарядь при Київському політехнічному інституті» (1907 р.). Вчений проводив практичні заняття зі студентами КПІ з питань дослідження сільськогосподарських машин. У статті вперше документно підтверджено факт очолювання С. М. Богоявленським Станції відразу після звільнення з роботи К. Г. Шиндлера у 1911–1912 рр. Доля вченого агронома після 1916 р. залишається невідомою.

Ключові слова: С. М. Богоявленський; К. Г. Шиндлер; П. Р. Сльозкін; Станція по випробуванню сільськогосподарських машин і знарядь; Київський політехнічний інститут

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Ship technology, slavery, repatriation and air transportation: continuity and change

Abstract. *The Trans-Atlantic Slave Trade, which occurred between the fifteenth and nineteenth centuries, displaced Africans and people of African descent into the New World. The trade affected and influenced several aspects of the world economy, boosting the economies of participating countries and creating what would become the African diaspora. While several elements of the trade have gained recognition in scholarship, ships, as the single most important medium of transportation for African slaves, have received little attention. We contribute to the discourse by placing ships at the center of discussion by highlighting the relevance and importance of this human and cargo carriage as a vehicle of slavery. We also paid attention to air transportation in the era of voluntary repatriation of people of African descent back to Africa for tourism, business and to pay homage to the motherland. We achieved these objectives through the use of written sources. These included books, journal articles and relevant sites and databases relating to the history of science, technology and slavery among others. The research highlights, among others, the following: the invention of ships has*



changed the course of world history. It has been the single most tremendous medium of transportation responsible for transporting millions of Africans into Europe and the New World creating the African Diaspora. The era of sailing and the cruise period have offered man the opportunity to navigate oceans and seas that were hitherto uncharted. It also ensured that trade relations between and among countries were solidified. Beginning in the XIV century when ships used rudders that ran on shallow waters, trade was organized on as small scale between countries. The fifteenth century became a significant date in the history of ship building as there was an improvement in sea faring and oceanic navigation. The double-ended ship gave way for full-rigged ships. An even greater milestone was achieved in the eighteenth century when the steam was invented. This period produced fast sailing ships which were less costly and it greatly influenced the triangular trade which had begun some two centuries earlier.

Keywords: ships; air transport; repatriation; slave trade; African diaspora

Introduction.

The history of transportation can be divided into three distinctive periods: the first period concerns the use of animals and winds; the second period saw the emergence of the steam-engine and later internal-combustion engine; and the third period has witnessed the era of space travel (Carpenter, Kalla-Bishop, Munson, & Wyatt, 1974). The interest of this paper lies within the second era where steam engines aided the transportation of Africans into the New World via sea; and the third period which has seen the return of Africans to Africa and is bringing people of African descent back to their roots.

As early as the fifteenth century, there were European presence on the shores of Africa. Internal trade between Europeans and indigenous African communities developed, with the Portuguese carving a niche for themselves in the booming market economy (Wilks, 1982). Of all the commodities, slaves occupied a central space in the trade. By 1479, slaves were procured from Benin, Congo and the Angola region and exchanged for gold and gold dust in the Gold Coast (Elmina). The sugar plantations in Sao Tome benefited, and for domestic purposes; Portugal is not absolved (Vogt, 1973; Wilks, 1982). The trade in slaves reached its peak in the eighteenth century not only due to the growing demands from the New World but most importantly, due to the invention and successes of the steam-engine.

The introduction of the steam engine served as an important invention that aided the repatriation of Africans to the New World. Becoming the ‘naval architects of the world’, the British leapfrogged in the science and technology of ships up to the beginning of the twentieth century (Matsumoto, 2006). Their position was aided by the industrial revolution of the eighteenth century which saw the single most innovative invention in technology, the steam engine. By the eighteenth century, naval architecture and marine engineering had provided innumerable additions. There was the introduction of a longitudinal system in 1862, the trial manufacture of a contra-

propeller in 1864 and the utilization of a balanced rudder originating in 1891 among others (Matsumoto, 2006). This invention made global commerce and migration easy.

The Trans-Atlantic Slave Trade is one of the most investigated subjects in scholarship. Studies of this event have culminated in the emergence of diverse fields of study, movements and religions such as African American Studies/Black Studies (Eyerman, 2002); African Diaspora Study (Falola & Childs, 2004); Pan Africanism (Poe, 2003; Falola & Essien, 2014; Adi, 2018); Rastafarianism (Bedasse, 2017); and the study of indigenous slavery in African communities vis-à-vis the chattel trade in the Americas (Perbi, 2004; Lovejoy & Falola, 2003). Ranging from database of the trade to the emergence of new cultures woven from African and West Indian roots, scholars such as Curtin (1989, 1984); Thornton (1992); Eltis (2000); Eltis, Lewis and Sokoloff (2004); Bailey (2005); Eltis and Richardson (2008); Holsey (2008); Falola and Warnock (2008) and Green (2012) have duly paid their dues. These scholars have explored African societies before and after European encounters, the effect of the Atlantic trade on all sides of the Atlantic, the horrors of the middle passage, life in the New World and the cultural exchange between people of African descent in the Americas and the homeland; Africa. Fett (2017) has also added her voice to the discourse on the Atlantic trade. She explores the lives of recaptured slaves in the dying years of the slave trade. Others, like Greene (1944) have explored mutiny on slave ships; while Klein and Engerman (1976) have discussed slave mortality on British ships from 1971-1979. Similarly, with a slight departure from Klein and Engermann, Stein (1980) rather places much emphasis on the French trade.

Another discussion has focused on the medium of transportation used in the voyages. The centrality of ships in the Atlantic Trade has been discussed by scholars such as Garland and Klein (1985); Smallwood (2007); Rediker (2007) and Borucki (2020). This notwithstanding, the literature is still silent on the mediums of repatriation from- the New World. Therefore, this paper contributes to this discussion by focusing on ships as mediums of repatriation of Africans from the New World and the changing trends for repatriation of Africans in the diaspora especially with further shifts and emphasis on air transportation to accomplish same ends.

The concept of repatriation has been defined differently by different scholars. For instance, Chapman (2018) explains repatriation as ‘to restore or return to the country of origin, allegiance or citizenship’. Similarly, Watkins (2006) views repatriation as “an act of returning something to its native country”. From a different perspective, Adelman and Barkan (2011) emphasize that “repatriation was for those recognized as citizens”.

However, in the current paper, the scope of repatriation goes beyond the definitions above by making reference to the beginning of when a group of people of a particular country/continent (in this case Africa) were forcefully taken from their original homes, transported, displaced, and resettled in the Americas and their journey back to their African home (voluntary migration). The voluntary migration unlike the involuntary migration occurs in waves, with the first set of repatriated Africans coming

from Britain and its colonies worldwide. The second wave involves people of African descent making trips to Africa (Bailey, 2005; Holsey, 2008; Falola & Essien, 2014).

By way of organization, the discussion in this paper is grouped into four sections. Part one explores ship technology from the earliest times to the 1700s. The section examines the history of ships and how it facilitated the Atlantic trade. Also, it looks at the time spent for a ship to successfully complete a voyage, the seating capacity of ships within this period, the number of slaves transported annually and the mortality rate on these ships. The second section centers on the impact of the industrial revolution on Atlantic trade and on the peak of the trade. The third section focuses on repatriation and how ships served as vehicles for transporting African returnees across the Atlantic. The fourth section discusses the changing trends in the medium of repatriation.

A history of shipbuilding and technology.

The history of shipbuilding has been divided into three major periods: the period before the fifth century; the Middle Ages (5th to 15th century); and since the 17th century. The latter period is further grouped into two distinct phases, the age of sail and power (Carpenter, Kalla-Bishop, Munson, & Wyatt, 1974). Ship builders in the first period relied on double clinker ship technology (Figure 1). The double clinker ships were built with overlapping timber that were identical at both ends; the bow and the stern (Schweitzer, 2013). It was less efficient streamlining but gave extra strength needed for safety in stormy waters. Below is an example of a clinker plank and its contrast, the carvel plank.

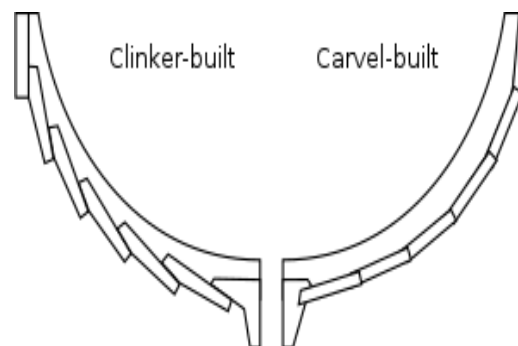


Figure 1. Ship build clinker ship technology (Carpenter, Kalla-Bishop, Munson, & Wyatt, 1974).

The gradual development of ship technology made headway especially in the 15th century. This century saw major improvements in seafaring and oceanic navigation. The full-rigged ships that consisted of three or more masts and five or six sails, which were square-rigged, were introduced in this period (Holmes, 1906). The double-ended ships, which had been in use for a long time, began to disappear when rowing gave way to sailing. In this period, rudders replaced steering oars. The rudder in these new ships was first attached to the side of the boat and then, after a straight stern post was adopted, firmly attached to the stern (Schweitzer, 2013).

Ships from the earliest time to the 15th century were smaller in size, with wood as the main hull (body). With this, trade was carried over shorter distances (Casson, 1994). The introduction of full-rigged ships was partly attributed to the large-scale trade that were organized. These trading activities were more frequent in occurrence and more distant in destination. To pack more square yards of canvas on a hull, it required multiple masts and a loftier and larger sail on each mast. As multiple masts were added, the hull was elongated; keels were often two and a half times as long as the ship's beam (width) (Casson, 1994).

Portugal became the center for exploration as the first school of oceanic navigation and trade was established (Worth, 2009). The feat of navigation led to the revolutionary journeys of Da Gama, Columbus and Cabot. Their explorations were made possible with the advent of navigational tools such as the compass (Pastor, 2010). This era witnessed the globalization of trade, and thus, the interior of Africa, that is, Africa beyond the Mediterranean, was soon to be explored. Worth (2009) has suggested that the ships sailed by Gama (Sao Gabriel, Sao Raphael and others) were probably about 100 to 120 tons, 75 feet long, and about 25 feet wide. They were low in the center with high castles on the bow and stern and armed with cannon. Each of the ships carried three sails; a square foresail in front, a mainsail in the center, as well as a triangular lateen sail in the rear (Figure 2). Also, Pastor suggests that Columbus' Santa Maria on the other hand was probably a caravel of 150–180 tons with hull frames fixed to the keel (Pastor, 2010).



Figure 2. Replica of Columbus' Santa Maria. The actual picture of the Santa Maria is unknown. However, 52 men are believed to have comprised the crew. Around this time, the stern castle had become an integral part of the hull (Pastor, 2010).

At the beginning of the 15th century, large ships weighed about 300 tons. By 1425, they were 720 tons. In the 16th century, full-rigged ships were continually used including the Carrack, a Mediterranean three-master and the Galleon (Figure 3). The Galleon became the most distinctive vessel between England and the Mediterranean.



Figure 3. The Galleon of 1610, with a length of 95cm, a width of 41cm and a height of 73cm (Carpenter, Kalla-Bishop, Munson, & Wyatt, 1974).

After the 15th century, the Dutch became very active in shipbuilding. They were able to build and operate merchant ships more cheaply than the English. By the 16th century, the Dutch *Fluyt* had become the sailing ship that was generally used by Europeans. The success of shipbuilding was to continue into the next century. In the 17th century, Holland attained her Golden Age in shipbuilding history as she was a great maritime power of the era (Davies, 1961). Their 17th century developments in ships were due to the eastern trade with Europe. As merchant ships grew rapidly, the Dutch traded as far east as Australia and Indonesia (Barbour, 1930).

The Venetians had been active sea traders since, at least, the Middle Ages. Until Holland became Europe's commercial center in the 17th century, Venice was the gateway to Europe's economy. As such, the *Venetian Buss* was supplanted by another Venetian ship, the *Cog* (Davies, 2021). Essentially, a *Buss* which weighed 240 tons with lateen sails was to be manned by a crew of 50 sailors. The crew of a square-sailed *Cog* of the same size had only 20 sailors. This began an effort that has characterized merchant shipping for centuries; to reduce crews to the minimum. This was particularly true of oceanic navigation because larger crews were expensive to pay and the large amount of provisions necessary was sometimes critical on long voyages.

The English responded to this change by improving their ships. For instance, the *East Indiaman* (Figure 4) of the 17th century, a large and costly ship, was intended to be England's entry into a fierce competition with the Dutch for trade in India and the

Spice Islands (Parthesius, 2010). Europe's trade with the East was built on already established production. What was needed were factories and settlements for trade. Coastal cities like Bombay (Mumbai), Madras (Chennai) and Calcutta (Kolkata) became important trading ports and centers (Marshall, 2005). The opposite was the case in the New World, where there was so little existing production of trading goods. Therefore, the establishment of ties required not only the pioneering of the trading route but also the founding of colonies to create new production. Shipping became larger and more continuous in the case of the colonies. As their advances in shipbuilding became necessary to protect their overseas trade, the result was the Atlantic Slave Trade, which will be discussed in subsequent sections. European countries' aim for the accumulation of capital, among other things, resulted in the vague acquisition of territories in Africa and the New World based on the use of strategy, canon power, and the acquiescence of the local authorities.



Figure 4. East Indiaman (Chatterton, 1934).

The Fluyt, unlike warships, was designed to carry as much cargo as possible; and was handled by fewer crew; cheaper to build; and was easy to sail (Parthesius, 2010). Eriksson's (2012) report on a 17th century Fluyt shipwrecked in the Baltic Sea gives a vivid description of it. The Fluyt had a bow of 1 meter which was shallower than the stern and a horizontal hull. It measured 21.8 meters between the stern and the sternposts. The main and fore masts carried two or more square sails and the third mast carried a lateen sail. In a similar work, Eriksson and Ronnby (2012) gave a description of the hull of the 'Ghost Ship'. The description depicts a rectangular ship with a carvel built hull measuring 27 m long and 7 m wide (Figure 5).



Figure 5. An Example of a 17th Century Dutch Flute (Carpenter, Kalla-Bishop, Munson, & Wyatt, 1974).

The various stages in the development of ship technology meant success for the Atlantic Slave Trade. What is presented thereunder are reports on the number of enslaved Africans who left the shores of Africa for Europe and the Americas from 1500 to 1700 (Table 1). From the table that follows, one could conclude that the ships were modified to be able to carry more slaves over the years.

Table 1. Slaves Transported from Africa (1500–1700) (Curtin, 1969).

Region	Year	Year	Year	Year	Year
Coastal Region	1500	1550	1600	1650	1700
Western ^a Coast	2000	2000	2500	2500	5700
Gulf of Guinea ^b	1000	2000	2500	3300	19400
West Central ^c	2000	4000	4500	8000	11000
Total	5000	8000	9500	13800	36100

- a. The areas in the table are further distinguished as: Western Region (from the mouth of the Senegal River including Arquin to Sierra Leone).
- b. Gulf of Guinea (from Malaquetta and Kwakwa coasts to Cameroon).
- c. West Central (from Cameroon to the Cape of Good Hope).

The western coast exported a total of 2,000 slaves annually in the 1500s. The number rose to 5.700 by the 1700s. The traffic on the Gulf of Guinea increased from 1.000 to 19.000 and on the West Central from 2.000 to 11.000. In addition to the economic and political reasons, we argue that another major reason for the increase in shipping capacity and voyages during the 18th century was the development of shipbuilding technology.

It is important to report that the route taken by ships depended on the nationality of the ship owner and the colony in which the slaves were to be dispatched in the Americas. The Portuguese, for example, controlled the trade in the West-Central African region of Angola, making Luanda and Benguela important ports. Such vessels headed for the Portuguese colony of Brazil via the South Atlantic Ocean. In the early years of the trade, until they sold their possessions on the Gold Coast to the British, the Dutch operated around Elmina, the Bight of Benin and the Bight of Biafra. Their slaves were sent to their South American colony in Surinam. Essentially, the vessel, *Maria Isabella*, was a Dutch ship that set sail from Rotterdam in 1775 for the West African coast, that is, the Ivory Coast, Gold Coast and Benin (Tripathi & Godfrey, 2007).

The industrial revolution and its impact on shipbuilding technology.

The eighteenth century, which marked the era of the industrial revolution, is a remarkable period in world history. It was in this period that steam, described as “the most powerful idea in the world,” was invented and developed by Professor James Watt of Glasgow University (Scherer, 1965). His development was built on the earlier works of Thomas Savery (1698) and Thomas Newcomen (1712) (Scherer, 1965). Newcomen erected a steam engine that combined, for the first time, a piston-in-cylinder arrangement and a basic motive principle involving the formation of a vacuum within the cylinder through the induced condensation of steam. This ‘atmospheric’ engine saw extensive use, especially for pumping water from the English coal mines. Aside from the above, the development of steam-technology aided several activities including shipbuilding (Brinley, 1993; Farr, 2003).

Since Portugal took the lead in world exploration and was the first to land on the African coast, most documents on shipwrecks and ships generally involved in the maritime trade are associated with her (Castro, 2003; Tripathi & Godfrey, 2007). Prior to this period, ocean-going ships in Europe, especially, Portugal were conceived in the 16th century on the Iberian Peninsula as a box with two ends (Castro, 2003). The frames that composed the central portion of the hull were designed and built using a simple and old non-graphic system developed in the Mediterranean and probably for the building of galleys (Castro, 2003). Carrel and Keith (1992) have presented the makeup of a 16th century ship used by sailors. In their work, they replicate the Santa Clara, an exploratory ship in the Columbian era. Using a technique called Mediterranean molding – a mechanically – generated geometric progression known as *graminhos* – ship builders in the era focused on areas with timber (Matsumoto, 2006). Thus, it is not

surprising that the Iberian Peninsula has been sighted in most shipbuilding technology documents (Carrel & Keith, 1992).

The Golden Age of the Dutch Republic in the 17th century recorded a number of merchant ships sailing the oceans of the world, including the Atlantic Ocean (Carrel & Keith, 1992). For the Dutch, a particular kind of ship known as the original *Duyfken* (*jacht*) has been identified by nautical archaeologists. A brief description of the *jacht* is that its speed limit is faster than most cargo ships and its cargo capacity is about 50 tons, making it a relatively smaller ship than other European ships (Burningham & Jong, 1997).

The United States' participation (as slave vessel owners) in the Atlantic Trade is a history of scattered data to which little attention has been paid. Despite this gap, pieces of fragmentary evidence can be accessed from some studies on the Trans-Atlantic Slave Trade. For instance, Greene's (1944) analysis of mutiny on slave ships recorded quite a number of American ships that suffered this fate. He further listed a number of US vessels, including *Little George* (1730), which had a slave capacity of 97 persons; *Adventure* (1764); *Hope*; *Thomas*; *Felicity* and *Thames* among others. Concerning the slave voyages in 1789, US vessels accounted for around an estimated 1,000 voyages, representing 58.2% (Marques, 2015).

In the years when the trade was abolished, US participation took the form of US ships, US capital and US flags. US ships were preferred in this period due to their relatively small nature, which was usually 40–50 tons. Such ships required few men to handle, with a crew ranging from 6–18 men (Greene, 1944). US shipbuilding technology advanced as steam was introduced. As already discussed, the eighteenth century saw great advancement in shipbuilding, which was improved upon by the nineteenth century in the US. In 1807, *the North River*, sometimes known as *Clermont*, a steam boat, began to operate on the Hudson River by Robert Foulton (Carpenter, Kalla-Bishop, Munson, & Wyatt, 1974).

The next phase of development saw the building of fast sailing vessels known as “yachts” or “clippers”. As Baltimore became the center for US shipbuilding, such ships became known as Baltimore Clippers (Carpenter, Kalla-Bishop, Munson, & Wyatt, 1974; Eltis, 2008). By 1818, *James Monroe* of the American Black Ball Line had sailed from New York to England, ushering in the era of fixed sailing dates (Carpenter, Kalla-Bishop, Munson, & Wyatt, 1974). In 1819, the American paddle ship, *Savannah*, (in Fig. 6) became the first ship to use steam power to cross an ocean. As a sailing ship, her funnel had a swivel elbow, which allowed smoke and sparks to be directed away from the sails and rigging. The paddle wheels could be unshipped and stowed on deck when not required. As these developments were ongoing, the trade to Brazil was booming and US slavers actively participated.

The figures below (see Figures 6–10) show examples of earlier ships that began to use steam engines.

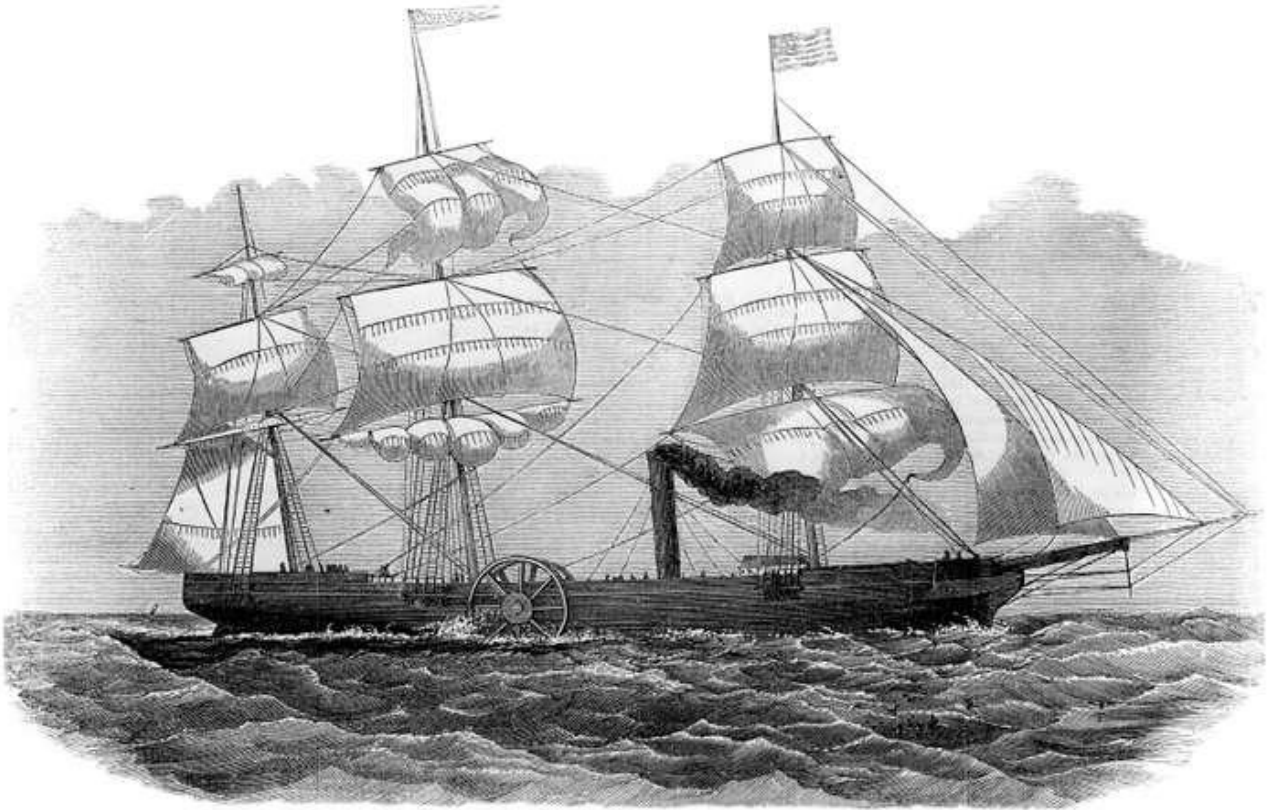


Figure 6. American Paddle Ship (Savannah). Source: Library of Congress, Washington, D.C. (file no. LC-1355) (<https://kids.britannica.com/students/assembly/view/168307> Accessed 14.04.2023).

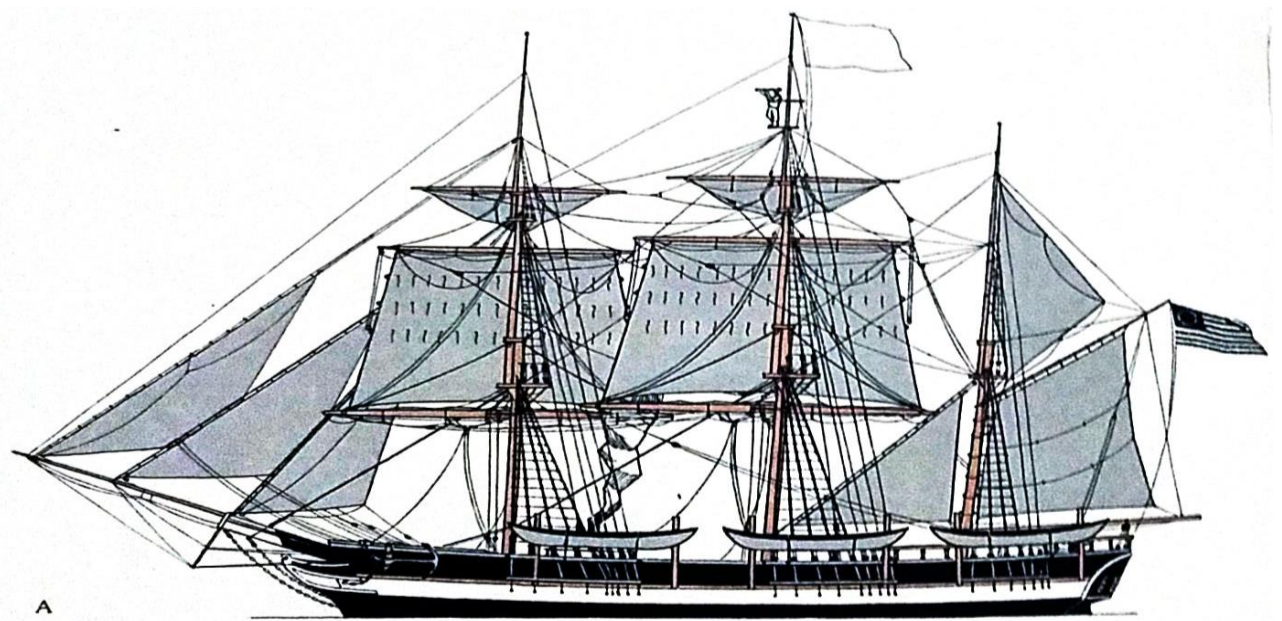


Figure 7. American Whaler (Carpenter, Kalla-Bishop, Munson, & Wyatt, 1974).



Figure 8. BruneGreat Britain (1843). A painting of the SS Great Britain's launch in 1843. The Great Britain, built in 1843, was the first steamship built with an iron hull (<https://www.ssgreatbritain.org/our-story/> Accessed 13/04/2023).

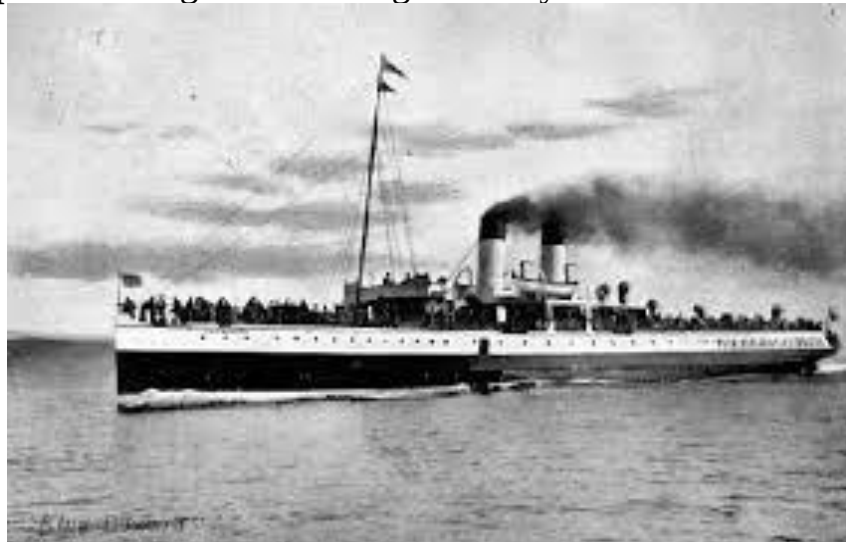


Figure 9. King Edward (1901). The 'King Edward', built in 1901, was the first commercial turbine ship which operated on the Clyde River in Scotland. It was however not the first turbine ship to cross an ocean as the *Victorian* became the first ocean going turbine ship (<http://www.roll-of-honour.com/Ships/SSKingEdward.html>).

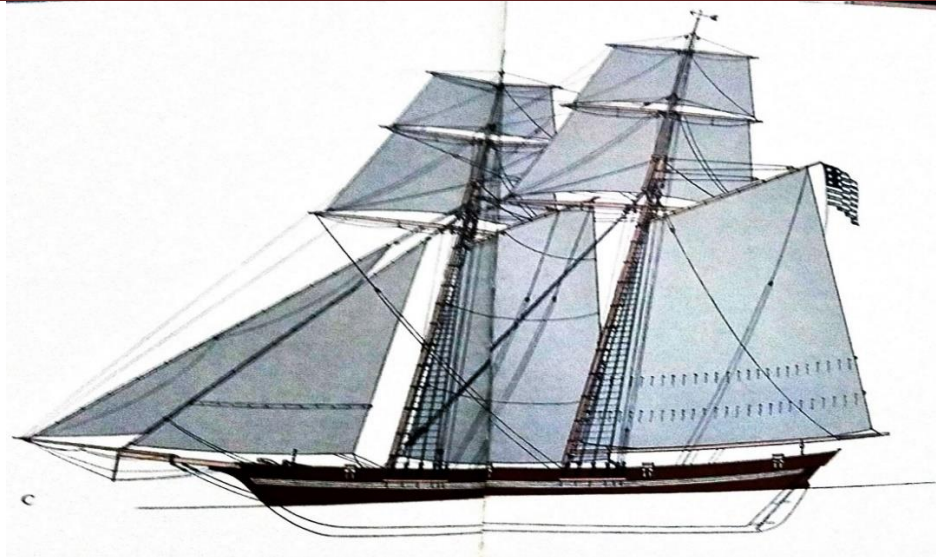


Figure 10. Baltimore Clipper (A 19th century American Ship) (Carpenter, Kalla-Bishop, Munson, & Wyatt, 1974).

Ships as Agencies for the Repatriation of Africans in the 18th century.

As already discussed, the eighteenth century saw a revolution in shipbuilding technology which also changed the face of the slave trade. The slave trade greatly impacted the Industrial Revolution just as the Industrial Revolution increased the volume of the slave trade. James cited in Inikori (2002), asserts that, “virtually all industries that developed in France in the eighteenth century originated from the production of manufactures for the slave trade in Western Africa or for export to the French American colonies.” Put differently, capital from the slave trade financed the industrial revolution. For Britain, where the Industrial Revolution began, the triangular trade aided her by providing markets in Africa and the production of raw materials in the West Indies. Concerning the triangular trade, ships set out on voyages from British ports with manufactured goods from her industries to Africa; the goods were sold and slaves were bought and loaded onto her vessels. The slaves were taken to the colonies in the West Indies and sold to plantation farmers, who used the slaves to produce crops such as cotton, tobacco, sugar and indigo. The plantation crops are then taken back to England for industrial consumption (Inikori, 2002).

Greene cited in Bailey (1990) hinted about the relationship which existed between the Industrial Revolution and the slave trade in the US:

“...the effects of this slave trade were manifold. On the eve of the American Revolution it formed the very basis of the economic life of New England; about it revolved, and on it depended, most of her industries. The vast sugar, molasses and rum trade, shipbuilding, the distilleries, a great many of the fisheries, the employment of artisans and seamen, even agriculture-all were dependent on the slave”.

The ongoing discussions point out several insights concerning slave repatriation, shipbuilding and the industrial revolution. One could be quick to infer from the above

that the availability of ships enhanced both slave repatriation and the industrial revolution. In essence, the industrial revolution also aided shipbuilding technology in several respects. In support of this, the literature suggests that the industrial revolution impacted the slave trade through the building of fast sailing ships, which were less costly and shortened voyages. The table 2 that follows provides some insights into the above.

Table 2. Average length of voyage from England to Africa and Africa to the West Indies (1791–1797) (Klein & Engerman, 1976).

	To Africa	To Africa	On Coast	On Coast	To West Indies	To West Indies
	Ships	Days	Ships	Days	Ships	Days
Senegambia	5	64.2	6	71.5	6	28.3
Sierra Leone	41	74.0	41	158.5	41	45.2
Windward Coast	19	67.5	18	175.7	19	52.6
Gold Coast	30	81.1	30	130.9	31	55.1
Bight of Benin	3	100.3	3	81.0	3	62.3
Bight of Biafra	111	75.4	113	99.9	116	60.4
Congo-Angola	67	106.0	69	95.2	69	56.0
Unknown	55	97.5	57	111.7	61	57.3
Total	331	85.6	337	114.2	346	55.7

It is difficult to quantify the number of slaves that left the shores of the African coast before the 1700s (Curtin, 1969). This challenge notwithstanding, some scholars have provided estimates of the number of slaves transported across the African region to the New World. Information from the table below contributes to the discussion on the number of slaves that were repatriated between the 1500s and the 1870s (see Table 3).

Between 1501 and 1875, an estimated 12, 521,337 Africans had been transported from Africa into colonies in the New World. The details have been further discussed as follows: between 1501 and 1600, a total of 277,505 slaves were transported from Africa. The number increased to 1,875,634 in the 17th century. By the 18th century, the figure had risen to 6,494,619. In the closing century of the traffic, the number stood at 3,873,579. Information from the Table 3 also reveals that the maritime powers who controlled the eighteenth-century traffic in slaves were the English, with an estimated number of 2,545,298; followed by Portugal and Brazil with 2,213,003; and France with 1,139,013.

Table 3. Number of Slaves Transported from Africa (1500–1875)¹ (Klein & Engerman, 1976).

Year	Spain/ Uruguay	Portugal/ Brazil	Britain	Netherland s	France	Totals
1501–1525	6,363	7,000	0	0	0	13,363
1526–1550	25,375	25,387	0	0	0	50,762
1551–1575	28,167	31,089	1,685	0	66	61,007
1576–1600	60,056	90,715	237	1,365	0	152,373
1601–1625	83,496	267,519	0	1,829	0	352,844
1626–1650	44,313	201,609	33,695	31,729	1,827	313,173
1651–1675	12,601	244,793	122,367	100,526	7,125	487,412
1676–1700	5,860	297,272	272,200	85,847	29,484	690,663
1701–1725	0	474,447	410,597	73,816	120,939	1,079,799
1726–1750	0	536,696	554,042	83,095	259,095	1,432,928
1751–1775	4,239	528,693	832,047	132	325,918	1,413,024
1776–1800	6,415	673,167	748,612	40,773	433,061	1,902,028
1801–1825	168,087	1,160,601	283,959	2,669	135,815	1,751,131
1826–1850	400,728	1,299,901	0	357	68,074	1,769,060
1851–1875	215,824	9,309	0	0	0	225,133
Totals	1,061,524	5,848,198	3,259,441	422,138	1,381,404	11,972,705

On the part of Britain, three trading ports were prominent in this period. These were Bristol, London, and most significantly, Liverpool, which became important ports for Africans. Between 1750 and 1776, 588 ships left Bristol for Africa; 10 left London, while 1868 left Liverpool. In total, 2,726 ships left these three ports within the period under review, with a capacity of 248 slaves per ship (<https://www.slavevoyages.org/assessment/estimates>). An annual average capacity per ship was estimated to be around 25,040 (<https://www.slavevoyages.org/assessment/estimates>). As Liverpool became the center for the English Slave Trade, between 1776 and 1787, she held about 69.4% of

¹ Information from the table was retrieved from: <https://www.slavevoyages.org/assessment/estimates>.

the trade and controlled 83.1% between 1795 and 1797 (<https://www.slavevoyages.org/assessment/estimates>). She was also responsible for transporting 303,737 slaves in the British West Indies through 878 ships with an average of 346 slaves per ship between 1783 and 1793 (<https://www.slavevoyages.org/assessment/estimates>). Nantes was to the French Slave Trade what Liverpool was to Britain in the eighteenth century. Between 1715 and 1720 saw a total of 63 ships which sailed from Africa carrying 24,200 slaves. Between 1748 and 1792, a total of 910 ships sailed for Africa. The Table 4 and 5 below present the number of ships that sailed from Africa and the slaves they carried.

Table 4. Number of Ships and Slaves Sailed from Africa (1721–1774) (Curtin, 1969).

Date	Number of ships	Number of slaves on board
1721 –28	71	19,100
1729 –33	62	16,400
1734–37	25	8,700
1738–45	180	55,000
1749–55	151	50,300
1764–74	217	69,300
Total	704	218,500

Between 1701 and 1800, a total of 6,091,000 Africans were shipped into the New World (Lovejoy, 1983). Distributed according to national carriers, the English were responsible for 2,468,000 (40.5%); the Portuguese, 1,888,000 (31%); the French, 1,104,000 (18.1%); the Dutch, 349,000 (5.7%); the Danes, 65,000 (1.0%); and Sweden and Brandenburg, 10,000 (0.2%) (Lovejoy, 1983).

Mortality in slave ships.

Available data suggests that some 12, 521,337 Africans successfully crossed the Atlantic to the New World. However, a lot more died en route. The mortality rates in slave ships were shaped by several factors, such as the route of the journey, the length, disease (yaws, fevers, white and bloody fluxes), as well as the care and services provided. Mortality in the earlier periods was high. In contrast, the 18th and 19th centuries saw a relative decrease in mortality rates (Curtin, 1969). Goulant cited in Curtin (1969) estimated the mortality rate in transit to Brazil as 15% to 20% in the 16th and 17th centuries which dropped to 10% in the 19th century. For the British, the Royal

African Company recorded a loss of 23.4% with a maximum annual rate of 29% in 1687. In the 18th century, however, a sample made by T. F. Buxton in 1791 for 15,754 slaves recorded a loss in transit of 8.75% (Curtin, 1969). Also, the French who were responsible for transporting 1,150,000 slaves to the New World, recorded a loss of 150,000 (Stein, 1980). Previously, the mortality rate for French ships before the 18th century was as high as 50% and this could be seen in the loss of *Saint Charles* which lost 190 out of 292 slaves; and *Louise Marquerite*, which lost 283 out of 340 slaves (Stein, 1980).

Table 5. Slaves taken from African Regions and Ships Used (Klein & Engerman, 1976).

	Jamaica	Jamaica	Grenada	Grenada	St. Vincent	St. Vincent	Other	Other
African Areas	Ships	Slaves	Ships	Slaves	Ships	Slaves	Ships	Slaves
Senegambia	1	194	2	419	2	371	1	121
Sierra Leone	21	5702	4	923	5	822	11	2634
Windward Coast	10	3579	3	601	4	895	2	217
Gold Coast	10	2854	-	-	9	2015	12	3920
Bight of Benin	1	317	-	-	1	195	1	350
Bight of Biafra	63	20677	23	4902	9	2985	22	6320
Congo-Angola	40	12727	8	2267	1	173	20	5908
Unknown	41	13426	3	598	9	2237	8	2327
Total	187	59476	43	9710	40	9693	77	21797

The Table 6 below is a representation of slave mortality in transit by ships from Nantes (French) by Coastal Region of Embarkation (1748–92).

The Table 6 shows how the route affected mortality in the French trade. Because Senegal and Guinea are a bit closer than Angola and Mozambique, mortality in the former is minimal. For example, in 1763–67 when 82 ships made voyages, a mortality

rate as high as 19.1% was recorded whereas the only voyage recorded in the whole period for Mozambique had a mortality rate of 22.3% mortality.

Table 6. Transit by Ships from Nantes (French) by Coastal Region of Embarkation (1748–92) (Curtin, 1969).

Time Period	Senegal	Guinea	Angola	Mozambique	Total
1748–51	2.5 (2)	20.7 (53)	18.1 (25)	-	19.4 (80)
1752–55*	2.4 (6)	14.4 (53)	17.1 (27)	-	14.4 (86)
1763–67	22.9 (5)	19.1 (82)	13.2 (47)	-	17.2 (134)
1768–72	10.0 (4)	18.7 (46)	10.1 (28)	-	15.2 (78)
1773–77*	14.0 (1)	12.4 (41)	7.4 (28)	-	10.3 (71)
1788–92	-	7.1 (5)	1.9 (9)	22.3 (1)	5.0 (15)
Total	10.4 (18)	17.2 (281)	12.5 (164)	22.3 (1)	15.2 (465)

Numbers in parenthesis indicate number of ships in each sample; *No sailing took place in 1756–62 and 1778–83 because of wartime.

Below is a sample of mortality rates in British ships in the 18th century.

Table 7. Mortality rates in British ships in the 18th century (Klein and Engerman, 1976)*.

Area	Average Mortality Rate (%)
Senegambia	2.9
Sierra Leone	3.71
Windward Coast	3.36
Gold Coast	2.75
Bight of Benin	4.30
Bight of Biafra	10.56
Congo-Angola	3.65
Unknown	1.5
Total	5.65

*With some modification.

For the British, the average mortality rate, especially in the last decade of the 18th century, was 5.65% which was low; the route via the Bight of Biafra recorded a high mortality rate (10.56%) as compared to the others (Table 7). Curtin (1969) asserts that mortality rate in the Eighteenth Century French ships were 12%, and 17% for the Dutch and the British.

African returnees.

The nineteenth century presented enslaved Africans an opportunity to taste freedom. Aside the many complicated questions surrounding emancipation, the period presented freed slaves the opportunity to be repatriated. Some of the abolitionist movements of the century repatriated Africans to Africa and the West Indies. After abolition, the presence of many Africans in the host countries posed a threat to the racial ideologies of the communities. The result was the resettling of former slaves established colonies. For instance, Britain established Sierra Leone in 1789 to settle Blacks from Britain (Enoh, 2014). Maroon slaves from Jamaica added to the population following their revolt in 1798 (Enoh, 2014). Blacks from Nova Scotia joined in 1800. Also, liberated Africans from the British patrols of the seas during the campaign against smuggling after the outlawing of the slave trade in 1807 added to this population (Curtin and Vasina, 1964). Between 1810 and 1864, Britain returned 149,800 re-captives and repatriated them to Sierra Leone, Liberia and the West Indies (Curtin, 1969). The US navy did same with 103 re-captives between 1837 and 1862 (Curtin, 1969). Soon a polyglot community of ex-slaves emerged in Sierra Leone under the control of Britain.

The British again undertook a voyage back to Africa, resettling about 800,000 slaves in Cameroon in 1838 (Enoh, 2014). To escape the discrimination, segregation, and humiliation that came with slave status and ancestry, most people opted for missionary work in Africa. Thomas Keith, for instance, set out from Jamaica in 1839 with only a letter of recommendation from his pastor to be a missionary to his brethren (Enoh, 2014). Those who could not offer their services in person sought to help in kind. In 1843, several families sailed from Jamaica with Alfred Saker and finally landed in the Cameroons; some went as missionaries and teachers, whereas others went as settlers. By 1858, they had become so numerous as to form a distinct community in Victoria, South-West Cameroon (Enoh, 2014).

Following the Sierra Leonean model, the American Colonization Society (ACS) decided to create a similar society for its freed slaves who wished to return to Africa. Under the aegis of the ACS, which saw it as a refuge for ‘unwanted’ Blacks in the United States, Liberia was established in the second decade of the nineteenth century as a ‘province of freedom to provide a home for the dispersed and oppressed children of Africa’ (Aje, 2014). It attracted Afro-West Indian immigrants like the Jamaican journalist John B. Russwurm, who established *The Herald* in 1830 (Aje, 2014). The most distinguished citizen of Liberia in the nineteenth century was another Indian, diplomat, intellectual, university president, publisher, minister of state, and proponent

of African personality, Edward Wilmot (Aje, 2014). The New England shipper Paul Kofie, one of the loudest exponents of repatriation in the first half of the nineteenth century, financed the settlement of twenty-eight ex-slave Liberians in 1815 (Aje, 2014). John Day, an African American, became the first Chief Justice of Liberia when he achieved independence from the ACS in 1847 (Aje, 2014). Another group that saw the repatriation of Africans to Liberia was the Liberian Exodus Association, led by Martin Delany and Bishop Henry M. Turner of the African Methodist Episcopal Church. The association purchased the ship, *Azor*, to transport over 250 exiles to Monrovia in April 1878 (Enoh, 2014).

Another African country that received returnees was Guinea. In Barbados, a West Indian Church Association was launched; under its auspices, persons of African origins returned to the ancestral continent (Enoh, 2014). Among them was John Duport, a young man from St. Kitts, who in 1855, went to the Rio Pongas region of what is now Guinea. With the cooperation of local chiefs and traders, Duport started a school at Falangia and followed it up by building a church. A stream of exiles followed; some stayed and others were forced by ill health to leave the continent.

The first wave of returnees into Ghana were Afro-Brazilians who had already settled along the shores of Nigeria, Togo and Benin (Essien, 2010). Historical records in Ghana date returnees to the 1830s. Essien states that:

“Sometime in the year 1836, Brazilians landed here (Accra), they came in one cargo ship; there were seven elders among them namely Mama Sokoto and others ... that land was granted to them ... the land remained the property of the Brazilian community.”

The twentieth century brought other returnees, including African Americans such as W. E. B. DuBois and his wife, Shirley Graham Du Bois; Julian Mayfield and George Padmore. Others who visited the young, independent state of Ghana included Malcom X, Julian Bond and Maya Angelou. Since then, Ghana has become a haven for Africans in the diaspora (Bob-Milliar & Bob-Milliar, 2014).

Ships of Leisure.

The developments in air transport redefined the use of ships. Cargo and container ships are still widely used to transport goods across oceans. The container ship is able to carry tons of goods which the passenger ship of the 19th century could not. What distinguishes modern cruise ships from ships in the previous century is the kind of material used and what fuels and powers the ship. Cruise ships are specifically designed to accommodate passengers as if they were in their homes (Figure 11). Eight different types of cruise ships have been identified; the mainstream cruise ship, the mega cruise ship, the luxury, the small, the adventure, the expedition and the river cruise ship, each built to meet a particular need (Bruns, 2008).



Figure 11. An example of a Cruise Ship.

(https://www.hollandamerica.com/en_US/cruise-ships/ms-oosterdam/6.html
Accessed 14.04.2023).

Air transportation as a major enabler.

The 20th century presented man with the opportunity to travel to distant lands in a shorter period of time. Developments in air travel in the first half of the century forced many passengers on ship lines to choose a different alternative. Air transport has since taken over ships as major vehicles in repatriation on a global scale and especially repatriating the African diaspora back to the homeland.

Since the beginning of the 21st century, several initiatives have been established by Africa to ensure the return of her people from the diaspora. The first of such initiatives was the declaration of the African Diaspora as the sixth region of the continent after North Africa, West Africa, East Africa, Central Africa and Southern Africa by the African Union in 2003. Two years later, the government of Ghana followed by offering special visas for African Americans in the Diaspora. Other countries have also responded by issuing citizenship to members of the diaspora to help them resettle in Africa (Bob-Milliar & Bob-Milliar, 2014).

Araujo (2010) has reported that the first initiatives to preserve West African coasts as tangible heritage sites started in the 1940s. Since then, Africans in the diaspora have found the need to return to these sites as a form of their commitment to their roots (Bob-Milliar & Bob-Milliar, 2014). Recently, the Government of Ghana declared and celebrated 2019 as the Year of Return, commemorating 400 years since the first slave arrived in Jamestown, Virginia (Tetteh, 2022). Initiatives such as these have seen a huge number of people of African descent troop into the country to visit their ancestral home via air travel. According to Ghana's Ministry of Tourism, Arts and Culture, about 1.1 million people arrived in Ghana in 2019 under the Year of Return programme, as compared to 956,372 in 2018 (Tetteh, 2022). Popular celebrities like the actor Idris

Elba, the WWE superstar Kofi Kingston, Steve Harvey and Rick Ross among others have featured in the return to Africa and Ghana in particular.

Of the numerous transport vehicles, air transport has facilitated the return of Africans. During their visit, they contributed immensely to the economies of Africa and the aviation industry. On the part of the host countries, the shores through which slaves were transported from Africa served and continue to serve as tourist sites generating income for the respective governments and other stakeholders. In light of the economy of the aviation industry, air transport has become the major vehicle through which governments have called upon or visited Africans in the diaspora.

Conclusions.

The invention of ships has changed the course of world history. It has been the single most tremendous medium of transportation responsible for transporting millions of Africans into Europe and the New World, creating the African Diaspora. The era of sailing and the cruise period have offered man the opportunity to navigate oceans and seas that were hitherto uncharted. It also ensured that trade relations between and among countries were solidified. Beginning in the fourth century, when ships used rudders that ran on shallow waters, trade was organized on small scale between countries. The fifteenth century became a significant date in the history of shipbuilding as there was an improvement in seafaring and oceanic navigation. The double-ended ship gave way to full-rigged ships. An even greater milestone was achieved in the eighteenth century when steam was invented. This period produced fast-sailing ships that were less costly and it greatly influenced the triangular trade that had begun some two centuries earlier. The eighteenth century alone witnessed the transportation of 7,000,000 African slaves into the New World. The Industrial Revolution, which began in England with the invention of steam, greatly benefitted from this maritime trade, as Africa provided a ready market for the goods produced by Britain's industries. Africa again produced labor for plantations in America, which in turn produced raw materials like cocoa, tobacco and sugar for industries.

The nineteenth century began the period of repatriation of slaves and descendants of former slaves who were taken to the Americas' via the middle passage. The first of such groups were slaves recaptured in transit as British and naval forces from other nations traversed the sea for slavers. Ships used in the period were the Baltimore Clippers and other small vessels. With no equivocation, recaptured slaves would be repatriated on ships. Initially, some of them settled in Sierra Leone and Liberia. The second group were afro-Brazilians who embarked on a voyage across the Atlantic and settled on the shores of Ghana, Nigeria and Benin. Air transport has ushered in the modern repatriation, where groups as well as individuals embark on the journey of returning home as visitors, with some choosing to stay permanently.

Examples of people who returned to the homeland either to visit or for a permanent stay include W. E. B. DuBois, Maya Angelou, Kofi Kingston, Naomi Campbell, Idris Elba, Boris Kodjoe, Michael Jai White and Rita Marley among several

others. Either for a permanent stay, business trips, or historical visits to the homeland, these returnees, among others in contemporary times, have resorted to the use of flights or airplanes among other means to achieve their endeavor.

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Корабельна техніка, рабство, репатріація та повітряний транспорт: безперервність і зміни

Анотація. Трансатлантична работоргівля, що відбувалася від XV до XIX століть, перемістила африканців та людей африканського походження в Новий Світ. Торговля вплинула на різні аспекти світової економіки, збагачуючи економіку країн-учасниць та створюючи те, що згодом стане африканською діаспорою. Хоча деякі аспекти работоргівлі набули визнання в наукових дослідженнях, кораблі, як найважливіший засіб транспорту для африканських рабів, отримали мало уваги. Ми вносимо свій внесок у дискусію, поставивши кораблі в центр дослідження, виділивши значення та важливість цього засобу перевезення людей і вантажу як засобу рабства. Ми також звернули увагу на повітряний транспорт у епоху добровільної репатріації людей африканського походження назад до Африки для туризму, бізнесу та віддання шани батьківщині. Ми досягли цих цілей за допомогою письмових джерел, таких як книги, наукові статті, а також веб-сайти та бази даних, що стосуються історії науки, технології та рабства, серед іншого. Дослідження підкреслює, серед іншого, наступне: винайдення кораблів змінило хід світової історії. Це був єдиний найпотужніший транспортний засіб, відповідальний за транспортування мільйонів африканців до Європи та Нового Світу, створюючи африканську діаспору. Епоха вітрильного спорту та круїзний період дали людині

можливість плавати в океанах і морях, які досі були незвіданими. Це також забезпечило зміцнення торгових відносин між країнами. Починаючи з XIV століття, коли кораблі використовували керма, які рухалися по мілководдю, торгівля між країнами була організована в дуже невеликих масштабах. П'ятнадцяте століття стало знаменною датою в історії суднобудування, оскільки відбулося вдосконалення морського плавання та океанської навігації. Корабель з подвійним торцем поступився місцем судам з повним оснащенням. Ще більша віха була досягнута у вісімнадцятому столітті, коли була винайдена пара. У цей період виготовляли швидкохідні вітрильні кораблі, які були менш дорогими, і це значно вплинуло на трикутну торгівлю, яка почалася приблизно два століття до цього.

Ключові слова: кораблі; повітряний транспорт; репатріація; работоргівля; африканська діаспора

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The nuances of the organizational preparation the electrification of the Kharkiv plant of the Russian Locomotive-building and Mechanical Society (1895–1896)

Abstract. *The transition to an electromechanical drive of equipment has become a new milestone in industrialization, which has led to significant: an increase in labor productivity and a decrease in the energy intensity of production processes. But on the Ukrainian lands of the Russian Empire, this innovation was not introduced until the mid-1890s, and only since that time the process of electrification of production at Ukrainian enterprises has been developed, however, with a simultaneous retain the steam-mechanical drive of equipment also. The Kharkiv plant of the Joint-Stock Company Russian Locomotive-building and Mechanical Society became the first enterprise not only in the Ukrainian provinces of the Russian Empire, but throughout the country, which used solely an electromechanical drive for all equipment. Taking into account this priority, the organizational preparation for the process of electrification of this enterprise also became the first experience in the country of introducing such an innovation, comparable, perhaps, only with the experience of switching from a mechanical to a steam-mechanical drive, which, however, was not studied in the Russian Empire. Simultaneously, the level of technical literacy of a part of the management of the Joint-Stock Company Russian Locomotive-building and Mechanical Society was not high enough to give a technical and economic assessment of the relevant innovations. Therefore, the organizational preparation for the electrification of the Kharkov plant of this Society was carried out without any clear*



methodological approaches, which in the discussion regarding the electrification scheme of the enterprise led to the replacement of the issue of choosing the best option from the most effective ones to the question of choosing the best one from the cheap ones. As a result, the Society's experts developed terms of reference for a compromise version of the electrification project, the essence of which was to install relatively new electrical equipment in terms of technical level, but operated according to an already outdated scheme, which made this electrification option neither efficient nor cheap, but politically acceptable for the entire leadership of Society. Eventually, it was possible to achieve the expected benefits from the electrification of the plant not from the implantation of the chosen scheme for its implementation, but by concluding strategic agreements with Siemens & Halske, according to which the Company's Management Board ensured it won the competition for the electrification of Society's enterprise at an affordable price, and Siemens & Halske, in turn, subsequently supplied the Company with its products at significant discounts.

Keywords: *electric drive; electromechanics; industrialization; innovations; mechanical engineering; production processes*

Introduction.

The electrification of the Kharkiv Plant of the Joint Stock Company (JSC) *Russian Locomotive-building and Mechanical Society (RLMS)*, better known as the *Kharkov Locomotive-building Plant (KhLP)*, was a significant event for the entire Russian Empire, since it became the first enterprise in the country, where to drive all production mechanisms were carried out exclusively with the help of electricity (The State Archive of Kharkiv Region [SAKhR], 1897a). Certainly, not all equipment used at the plant was equipped with an individual electric drive, which, in fact, is mandatory in today's perception of the electrification of production. However, in the era under consideration in Russia, even the replacement of steam engines on the drives of gearboxes of overhead transmissions of workshops with electric motors was already considered a significant step towards the electrification of production processes and, moreover, the most cost-effective step (Livshic, 1929). Thus, *KhLP*, at the time of its commissioning in 1897, was the most electrified enterprise in the country according to the ideas that existed at that time about economically viable methods of electrification, which makes it very interesting to study ways to achieve this result. Despite such a significant role of *KhLP* in the electrification of the industry of Tsarist Russia, and then – Soviet Ukraine and the Soviet Union as a whole, historians have considered the issue of the origin of this process at the plant under research itself superficially, although quite a lot of scientific works devoted to the study of the history of this enterprise have been published. So, in the article *Background of creation, further development, and establishment of Kharkiv Locomotive Plant*, the authors outline those organizational, financial, construction, social, personnel and design problems that JSC *RLMS* had to face during the construction and commissioning of the plant in Kharkov, however the moment of electrification of this enterprise was completely missed (Strelko,

Berdnychenko, Khromova, Spys, 2022). Researcher O.V. Diakova also did not consider the process of electrification of the *KhLP*, concentrating on the problem of the financial and social situation of the plant workers (Diakova, 2018). In the scientific works of O. L. Sorochynska, the process of mastering new products by the enterprise has been studied, the general reasons for the intensive development of steam locomotive building in the Ukrainian provinces of the Russian Empire and the role in this *KhLP* has been researched, but neither the electrification of the plant itself, nor its role in the development of the electrification of the domestic industry as a whole have been considered in any form (Sorochynska, 2013, 2015a, 2015b). In the study by N. Annienkova *Vyrobnytstvo verstatnoho obladdannia na Kharkivskomu zavodi Rosiiskoho parovozobudivnoho i mekhanichnoho tovarystva (kinets XIX - pochatok XX st.)* regarding the stage of the creation of *KhLP*, there is only information that the enterprise was originally focused not only on the creation of steam locomotives, but also metal-cutting machines (Annienkova, 2014). Information that *KhLP* was electrified is available in the monograph by A. A. Voskresenskij *Revolucionnaya bor'ba rabochih har'kovskogo parovozostroitel'nogo zavoda (1895–1917)*, however, neither the degree of its electrification nor how this process was organized during the construction of the plant was described by the author (Voskresenskij, 1958).

To a certain extent, the electrification of the *KhLP* has been reflected in scientific works devoted to the study of the development of electrical engineering and the electric power industry in Ukraine. So, for example, from the publication: *The development of researches in the electrical engineering field in Kharkiv Practical Technological Institute*, it follows that the power plant of the plant under study was almost the first power generating enterprise in Kharkiv (Radoguz, Zaitsev, Gutnyk & Tverytnykova, 2019). And from the article: *Obsiahy vykorystannia elektrychnykh mashyn na promyslovykh pidpriemstvakh Slobozhanshchyny naprykintsi XIX st.* we can get information about the capacity of the factory power plant and the number of production equipment equipped with an individual electric drive, originally installed at *KhLP* (Annienkov, 2014). However, in the scientific works of this profile direction, as well as in the works on the history of the creation of the *KhPZ*, the issue of organizing the electrification of the plant at the building stage has not been covered, which allows us to consider it as unexplored.

Research methods.

In preparing the article, the following methods like: problem-chronological, retrospective, dia- and synchronic methods, as well as the periodization have been used. On the basis of the diachronic method, the dynamics of external factors influencing the nature of the production processes electrification carried out at *KhLP* have been monitored, and the synchronic method has been used in the static positioning of these factors among themselves. The periodization method made it possible to single out the individual stages of the electrification process of an enterprise during its creation, and the problem-chronological method has been used to sequentially study

each of these stages in the entire complex of profile problems being solved. The retrospective method made it possible, on the basis of the principles of historicism, to restore the scientific and technical- technological level of approaches to solving the problems of electrification of machine-building enterprises used in organizing this process in the study period. As a result of the application of this methodological apparatus, a real historical picture of the organization of the preparation of the process of electrification of the *KhLP* at the stage of creating an enterprise has been drawn up, which meets the principles of historicism and objectivity.

Results.

When planning activities for the creation of *KhLP*, the problem of the formation of its fixed assets by the Board of JSC *RLMS* was divided into three tasks: 1) design and construction of buildings and structures; 2) calculation of the necessary production equipment, auxiliary machines and mechanisms, and their arrangement of the plant; 3) design and equipping of the electric power supply system of the enterprise (SAKhR, 1895a). The organization of the solution of the last of them was entrusted to a member of the Board of JSC *RLMS*, mining engineer Nikolai Nikolayevich Koksharov [1857–1941] (SAKhR, 1895a). On his initiative, in November 1895, the Board involved in the development of technical specifications for the electrical-energy equipment of the *KhLP*: a lecturer of electrical engineering at the St. Petersburg Nikolaev Military Engineering Academy and the Electrotechnical Institute, a consultant of the Main Engineering Directorate of the Military Ministry, engineer-captain Ludomir Vatslavovich Sventorzhetsky [1865–1925?] (Fig. 1) and lecturer of the St. Petersburg Institute of Technology Alexander Aleksandrovich Voronov [1861–1938] (SAKhR, 1895b).



Figure 1. Ludomir-Mikhail-Octavian Vatslavovich Sventorzhetsky.

Meanwhile, already in December 1895, the director of the plant, Pavel Pavlovich Rizzoni [1857–1937], understood the need for constant expert-consulting support for the process of electrification of the enterprise for the entire period of its construction, about which he notified the Board of JSC *RLMS*. Members of the Board unanimously supported P. P. Rizzoni, approving as such a consultant with a salary of 150 rubles monthly L. V. Sventorzhetsky (Fig. 1) and with enrolling him in the service of the

RLMS from the time when he actually began to cooperate with the JSC, that is, from November 15, 1895 (SAKhR, 1896a).

An analysis of the preparatory steps taken by the Board of JSC *RLMS* to organize the electrification of its Kharkiv plant makes us pay attention to the fact that they initially did not consider any other options for the energy supply of *KhLP*, except as for exclusively electricity, what in the chronological period we are considering was atypical for the industrial sector Russian Empire. The most common in the country at the end of the nineteenth century the power supply scheme for the production equipment of machine-building plants was the transfer of mechanical energy to it through belt (and in some cases – chain) drives from transmissions located under the ceilings of workshops. The latter, in turn, were mechanically connected to gearboxes driven by steam engines, which had different combinations of placement: from one per shop to one for each overhead transmission – depending on the absolute value of the power consumption of the entire shop, as well as on the type of steam engine used (piston or turbine). Electricity at such enterprises, according to, for example, L. Davydova, was used only for lighting, although we cannot exclude cases of using electricity to drive industrial equipment, but these cases, if they did occur, were definitely isolated (Davydova, 1966). This statement is based on the fact that in the considered scheme of combined electric and steam power supply of machine-building enterprises, block-stations were used as electric generating plants. The principle of their design was that the electric power supply to the corresponding equipment was supplied from batteries charged by a generator connected to an external or internal combustion engine, which, in view of the low productivity of such systems due to the then imperfection of batteries, a priori excluded the possibility of connecting to them, along with lighting, any-more power electrical force devices. To the above, it can be added that if there are still references to the use of block stations for arranging factory lighting in historical literature or documents, then no information has yet been found about the use of these stations as power sources for power equipment, which, in fact, confirms the imperative stated earlier about the objective conditionality of the singularity of such cases at the machine-building enterprises of the Russian Empire in the era under study (Orlov & Budagov, 1894; Suvorin, 1895; Annienkov, 2014).

A less common, but actively gaining popularity in the second half of the 1890s [especially in the Ukrainian provinces of the Russian Empire], the power supply scheme for new metalworking plants was a combination of the use of steam engines and factory power plants. The high productivity of the latter [compared to block stations] made it possible to significantly electrify production processes, which, however, was limited by technological energy intensity, such as, for example, inherent in metallurgical operations. This restriction was caused by the imperfection of the “protectionism policy” pursued by the tsarist government, resulting in a very high price for practically not manufactured in the country and imported from abroad: both used directly by the siderurgy and in the electric power industry large electric machines [such as, for example, presented on fig. 2], made their use much less cost-effective than

the use of special steam engines (Alexandrov et al., 1957). Therefore, large-scale engineering plants, in production processes in which a large share was occupied by the manufacture of bulky and heavy metal blanks, as well as giant metallurgical plants, which have large repair and machine-building workshops, provided the electric power only metal-cutting and mechanical assembly equipment. Among such enterprises founded at the same time as *KhLP*, metallurgical plants can be attributed: the Belgian JSC *Iron-rolling plant* in Konstantinovka [1896], the *Donetsk-Yuryevsk metallurgical JSC* in Alchevsk [1895], the *Nikopol-Mariupol mining and metallurgical JSC* in Sartana [1896], *Russian-Belgian metallurgical JSC* in Enakievo [1897], as well as the Kramatorsk machine-building plant [1899], the *Naval machine- and shipbuilding plant* in Mykolaiv [1895]; locomotive-building plant Hartmann in Lugansk [1896] (Ministry of Finance & Ministry of Trade and Industry of the Russian Empire, 1911).

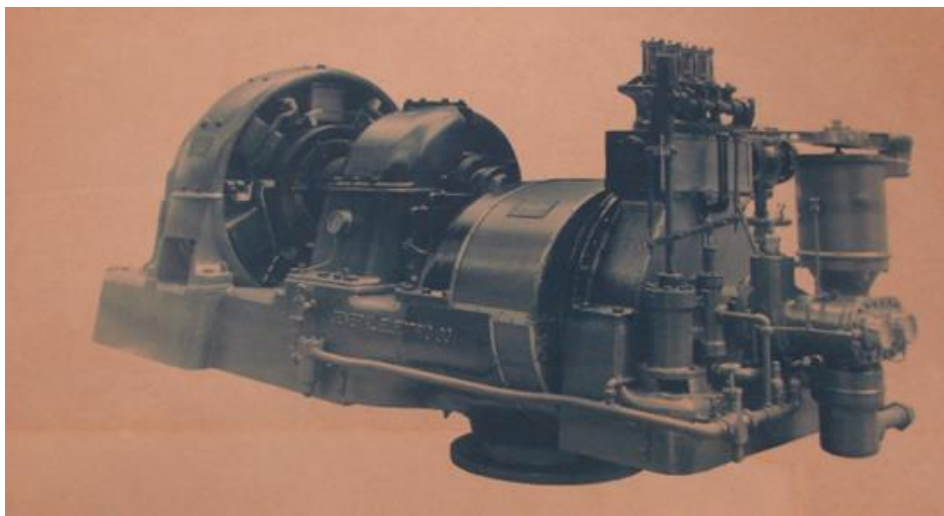


Figure 2. Electric power equipment consisting steam turbines geared to direct current generators 250V/5MW made by General Electric Company and which provided to Russian Empire at the end of the 19th – begin 20th century. (SAKhR, 1916).

Therefore, based on the situation described above, and also taking into account the type of the main product of the enterprise under study, we come to the conclusion that, when deciding on the full electrification of all production processes at the *KhLP*, the Board of JSC *RLMS* in advance intended to receive the large metal blanks necessary for the plant from outside. This is confirmed by the fact that even before the start of the construction of the plant, the Chairman of the Board of JSC *RLMS* entered into relations with the Boards of steel and copper rolling enterprises to discuss the possibility of concluding long-term contracts with them for the supply to *KhLP* of large-sized: steel casting, steel and copper rolled products, forgings (SAKhR, 1895c). This approach of exclusion from the technological chain of operations for casting and plastic deformation of massive blanks made it possible to carry out a complete electrification of production processes at *KhLP* without the need to purchase expensive electric drives for the corresponding equipment, what, however, it was not the know-

how of JSC *RLMS*, since in the 1890s it was already widely used in American mechanical engineering and begin mastered by European mechanical engineering (Atmakin, 1936). At least one of the co-founders of JSC *RLMS*, Philippe Bouheu [1836–1899], co-owner of the machine tool plant in Montzeron [France] that he and his brother Étienne inherited from his father, actively studied this American practice and applied it both at the specified plant, and at other enterprises created by the brothers in 1895 *Société Française des Corps Creux* in Montbard [France] (Morvan, 2023). So, there is every reason to believe that the method of placing orders for large: rolled products, forgings and castings at specialized factories, instead of being manufactured by machine-building enterprises on their own, was brought to the Russian Empire by Ph. Bouheu, as one of the directors of the Board of JSC *RLMS*. However, this method was approved for use only according to the conclusions from the excursion trip of P. P. Rizzoni 14–31 August 1895 in the engineering factories of France, during which he together Ph. Bouheu visited both the Bouheu brother's plants and other engineering factories, including plant of the *Société Alsacienne de Constructions Mécaniques* in Belfort (SAKhR, 1895d).

Meanwhile, the director of the *Société Alsacienne de Constructions Mécaniques* was Alfred George de Glehn [1848–1936], one of the most famous steam locomotive designer in Europe at the time¹, under whose leadership in Europe at 1895 were built already three successfully operating locomotive-building plants according to the same scheme for organizing the production process, according to which *KhLP* was later built (SAKhR, 1895d; The Times, 1936). Thus, as we can reasonably assume, the final decision on the full electrification of the JSC *RLMS* plant in Kharkov was made by the Board of the Company only after P. P. Rizzoni, who's delegated by it to assess the possibility of the effective functioning of the enterprise on the accompanying such electrification of the scheme for organizing production processes in the conditions existing in the Russian Empire, confirmed this. At the same time, attention is drawn to the fact that even before the specified trip abroad P. P. Rizzoni, and three and a half months before A. A. Voronov and L. V. Sventorzhetsky were attracted as experts [that is, before the official final approval of the decision on the full electrification of the *KhLP*], the representative office of *Siemens & Halske* in St. Petersburg has already sent to the Board of the *RLMS* a proposal (fig. 3) for its services in drawing up a project for the electrification of the plant (SAKhR, 1895e).

All other firms specializing in the Russian Empire in the electrification of industrial facilities: both with their own produced electrical equipment, and on the basis of purchased electrical equipment or in a mixed scheme, turned to JSC *RLMS* with similar proposals much later. So, for example, a representative of the Swiss electrical engineering concern *Brown-Bowery* submitted a corresponding proposal in October 1895, and representatives of the specialized Kyiv technical office of the *Henry Smith*

¹ His father was a nobleman of Prussian origin, who moved from near Tallinn (Estland province of the Russian Empire) to England, therefore, in the documents of the Russian Empire, the spelling of the surname "de Glehn" in its German transcription may be found: "von Glehen" or "de Glehen"].

& Co Trading House – at the end of November of the same year (SAKhR: 1895a, 1895f).

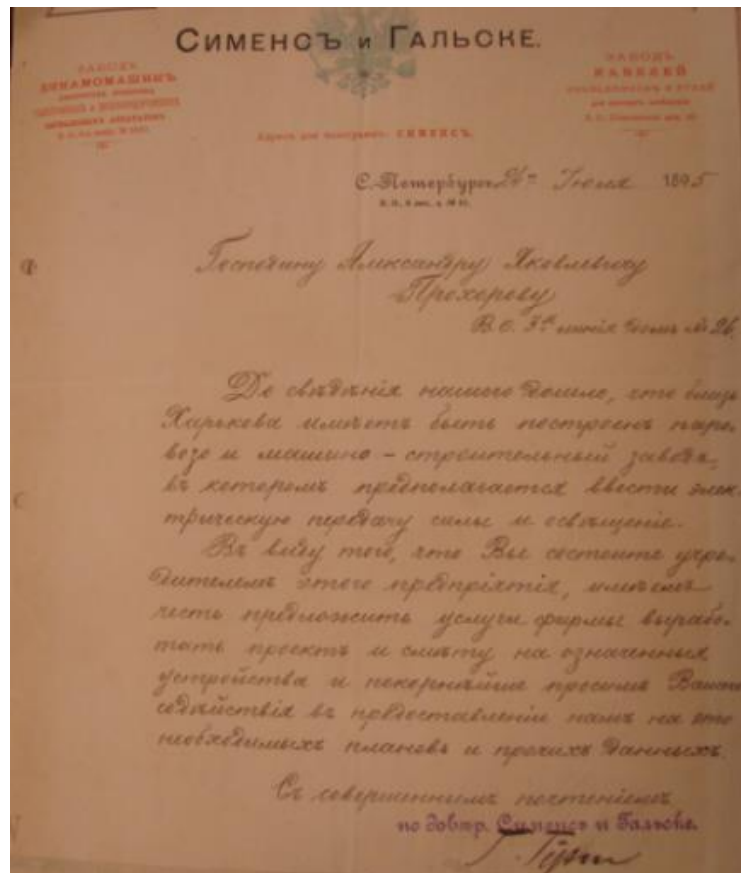


Figure 3. Letter of offer from *Siemens & Halske* for the provision of their services in the design of the electrification of *KhLP*, dated July 24, 1895 (SAKhR, 1895e).

However, on October 19, 1895 [one and a half months before the announcement of the tender for the *KhLP* electrification project], the *Siemens & Halske* representative already submitted a preliminary estimate for the plant's electrification, which could not be done without at least a preliminary corresponding design, which, in turn, also it would be impossible to draw up without having at least a master plan for an enterprise under construction with the power parameters of the equipment intended for use displayed in it (SAKhR, 1895g). By the way, chronologically, this event almost coincides with the refusal of *Usines Bouheu* to fulfill its shareholder contractual obligations regarding the provision of a detailed project for the construction of the *KhLP*, which occurred after the board of JSC *RLMS* received from it the master plan of the plant and before it was supposed to receive detailed design [before October 13, 1895] (SAKhR, 1895a). The mentioned refusal was never officially announced by *Usines Bouheu* and was realized by a simple failure by her to fulfill her obligations, which led to the need to hire the architect Alexander Ivanovich von Goghen [1856–1914] by the JSC *RLMS*, and subsequently made it possible for the Board of the JSC

to accuse *Usines Bouheu* of sabotage *KhLP* design work (SAKhR, 1896a). However, it should be noted that this accusation did not receive any legal formalization, whereas, for example, *Usines Bouheu's* untimely fulfillment of its shareholder obligations to supply *KhLP* with production equipment ended with the filing of financial claims against this company by JSC *RLMS*, which, after settlement of the issue of their magnitude, were recognized and satisfied by the *Usines Bouheu* (SAKhR, 1897b). That is, the failure to provide *Usines Bouheu* with a detailed *KhLP* project, apparently, did have reasons, however for the legal justification of which *Usines Bouheu*, most likely, did not have documented facts, and that did not lead to the official registration its refusal to fulfillment of its shareholder contractual obligations in this part. At the same time, these reasons, as we can assume, were of a discrediting nature for certain influential members of the Board of JSC *RLMS*, leading, if they were made public, to certain reputational losses of the Company even without documented facts, but only on the basis of a logical comparison of the showed results of the relevant events, which and became an obstacle for JSC *RLMS* to file appropriate financial and legal claims against *Usines Bouheu*.

In any case, the fact of leakage of information about the plans for electrification of the plant of JSC *RLMS* planned for construction in Kharkiv committed by the Board of this Society is obvious, as is the fact that the largest volumes of this kind of information were received by the St. Petersburg representative office of *Siemens & Halske*. This is what allowed *Siemens & Halske* to prepare more thoroughly than all other future bidders for the electrification of *KhLP* to prepare for the competition of projects, among other things, by initiated the use of a direct type of electric current at the plant, the advantages of which it was detailed by the company's engineers in the previously mentioned estimate of the electrification project enterprises dated October 19, 1895 (SAKhR, 1895g). In fact, all these arguments were used by A. A. Voronov, L.V. Sventorzhetsky and P. P. Rizzoni when they drew up the terms of reference for the electrification of the plant in November 1895, and if they were not quoted, then at least they were repeated very close to the text of the explanations of the *Siemens & Halske* engineers (SAKhR: 1895g, 1895h). However, otherwise, the specified terms of reference differed significantly from the method of electrification of the *KhLP* proposed by *Siemens & Halske*, primarily because of the chosen by A. A. Voronov, L. V. Sventorzhetsky and P. P. Rizzoni power generation scheme. So, *Siemens & Halske* proceeded from the need to use 6 dynamos with a total capacity of 1 250 hp, of which one machine in 250 hp had to work exclusively for lighting, while the specialists of JSC *RLMS* considered 3 dynamos with a total capacity sufficient of 900 hp, powering the lighting according to the traditional scheme – from a battery block-station charged by one of the total numbers of installed generators at a time when production processes at the plant were not carried out (SAKhR: 1895g, 1895h, 1895j).

The effectiveness of the proposed A. A. Voronov, L. V. Sventorzhetsky and P. P. Rizzoni plant power supply scheme requires additional historical research aimed at studying the economic efficiency of the use of battery block-stations in the era under

consideration in the Russian Empire in general and in its Ukrainian territories in particular. The absence of such studies greatly complicates the possibility of an objective technical and economic assessment of the option developed by these specialists for organizing the electric power supply of *KhLP*. However, it was in the economic context that the relevant terms of reference were studied by N. N. Koksharov, which, based on his approval of this option, as well as the information we have about the planned exclusively single-shift operation of the plant, allows us to assume it's then economic feasibility, unless, of course, we take into account the possible prospect of the plant switching to a multi-shift operation (SAKhR, 1895k). To the above, it should also be added that the current economic aspects in a whole influenced the preparation of the terms of reference for the electrification of the *KhLP* by the specialists of JSC *RLMS* more than the technical nuances that determine the prospective economic efficiency of the planned measures for the electrification of the enterprise. So, for example, when choosing the type of electric current used, as mentioned earlier, the arguments of *Siemens & Halske* engineers were used, based on the fact that current transportation within the enterprise will not cause a significant reduction in the efficiency of the power grid as a whole due to losses in her energy in the case of choosing direct current. However, it should be noted that this argument is unequivocally fair: 1) only when comparing the efficiency of the power supply network and the efficiency of the shafting network of the corresponding mechanical transmissions, and not the efficiency of the DC network and the efficiency of the network AC current; 2) on the condition that the power grid will not grow further due to the expansion of the plant, – and this was definitely known to such qualified specialists as A. A. Voronov and L. V. Sventorzhetsky, who's nevertheless supported this argument. At the same time, both them and P. P. Rizzoni, and N. N. Koksharov mentioned the technical side of the issue of choosing the type of current as if in passing, but the cheapness of complete electrical equipment operating on direct current compared to the same, but operating on alternating current, is considered in more detail, by the way, as well as by *Siemens & Halske* engineers (SAKhR: 1895g, 1895h, 1895k).

Meanwhile, the interest of *Siemens & Halske* specialists in focusing the issue of choosing the type of current on the cheapness of equipment is entirely understandable, since during the study period, two electrical companies, *Westinghouse* and *Allgemeine Elektrizitäts Gesellschaft* [AEG], had patent priority for the manufacture of equipment operating on alternating current, although it was disputed by them between yourself (Annikov, 2020). Therefore, by offering AC electrification at *KhLP*, *Siemens & Halske* a priori weakened their competitive position if *Westinghouse* and *AEG* were involved in the tender for this event. Although it should be recognized that the arguments of *Siemens & Halske* regarding the need to install additional transformer equipment when choosing an alternating current electrification scheme, which inevitably increases the cost of this project, are absolutely true, but do not take into account the fairly fast payback rates of the corresponding costs. In turn, the specialists of JSC *RLMS* also had a reason to lean towards choosing a direct current, since,

according to the agreement between the shareholders of JSC *RLMS*, part of the authorized capital of the Company, attributable to Ph. & É Bouheu, were supposed to compile, among other things, the necessary *KhLP* metal-cutting machines with an individual electric drive and electric overhead cranes manufactured by *Usines Bouheu* and consuming direct current (Annikenkov, 2014). That is, approximately 20% of the production equipment planned for operation at the *KhLP* (and de facto purchased) was already focused on the use of direct current even before the development of the technical assignment for the electrification of the plant.

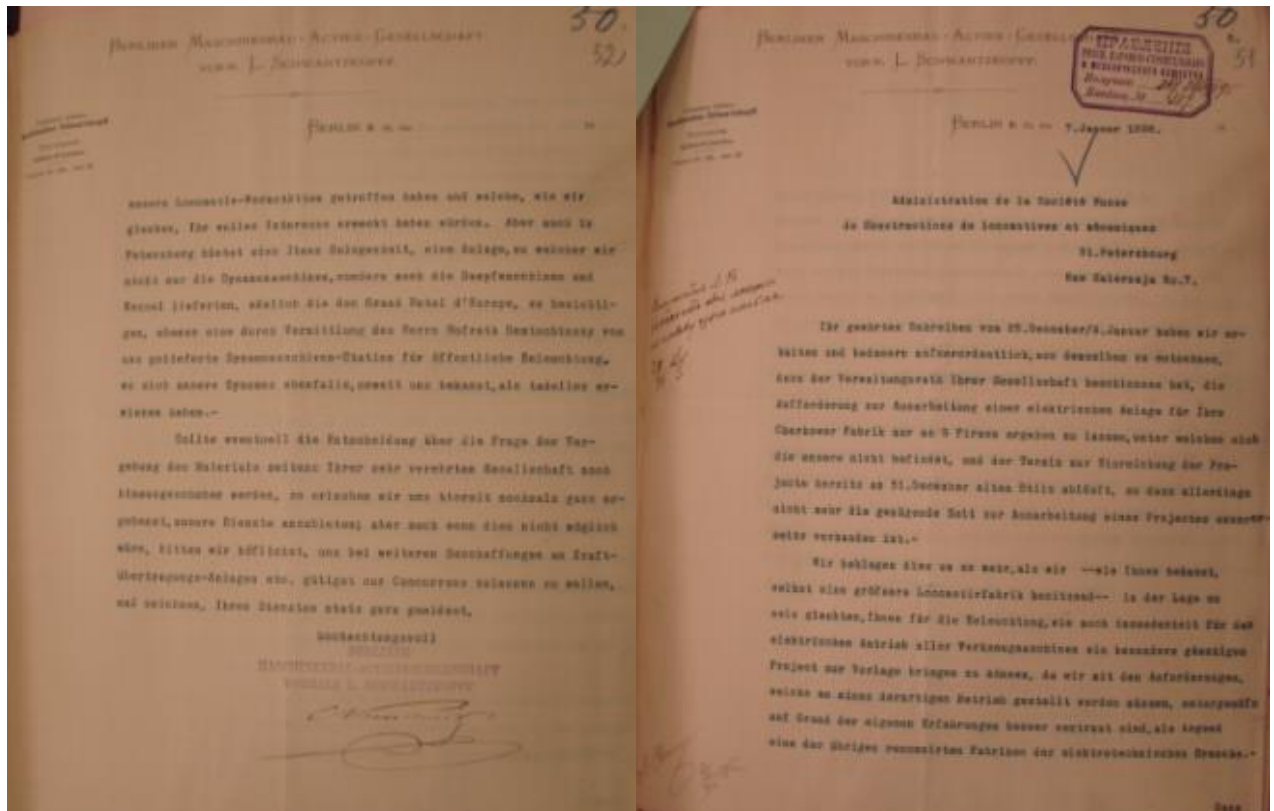


Figure 4. Letter from *Maschinenbau Schwartzkopf* to the Board of JSC *RPMO* regarding its participation in the tender for the electrification of *KhLP* (SAKhR, 1895).

Thus, according to the coincidence of opinions of the members of the Board of JSC *RLMS*, the director of *KhLP* and electrical experts, it was decided to use direct current at the enterprise, which formed the basis of the technical specifications for the project for the electrification of the plant, for which, at the insistence of N. N. Koksharov and L. V. Sventorzhetsky, only five European electrical companies that had a high reputation and guaranteed not only high-quality, but also fast execution of work were admitted – *Oerlikon* [Switzerland]; *Siemens & Halske*, *AEG*, *Lahmeyer* [all three from Germany]; *Hillairret* [France] (SAKhR, 1895b). However, an analysis of the correspondence of JSC *RLMS* with foreign companies shows that, despite the official decision of the Board, the notice of this tender was sent not only to these

companies. So, for example, the German *Maschinenbau Schwartzkopf*, which owns both a steam locomotive plant in Germany similar in terms of production scheme and productivity to *KhLP*, and an electrical factory that produces the entire set of electric machines and equipment necessary for the electrification of such enterprises, also was receive notification of this tender, and simultaneously with the technical task for the relevant project and with notification of her non-participation in the competition, and just a week before it was supposed to take place. At least, this follows from the response letter from *Maschinenbau Schwartzkopf* to the Board of JSC *RLMS* (fig. 4), although such facts are not reflected in the minutes of the meetings of the Board of the Company (SAKhR, 18951). This fact, as well as the refusal of JSC *RLMS* from the plan initially approved by its Board to take as the basis for the electrification scheme of *KhLP* the corresponding schemes already in use at enterprises similar to this plant, *Société Française des Corps Creux* or *Société Alsacienne de Constructions Mécaniques*, gives reason to believe that until the very end of the process of preparing for the tender for the electrification of *KhLP*, the Board of JSC *RLMS* was unanimous only in its opinion regarding the full electrification of the plant, but the ways of its implementation among the members of the Board caused disagreement. The essence of these disagreements lay in the plane of choice between the power supply of the electrical systems of enterprises, already dominant in Europe, exclusively directly from electric generators, and the power supply of factory power networks from battery block stations, which prevails in the Russian Empire.

The first option did not raise doubts about its effectiveness among Russian electrical engineering specialists, however, the lack of experience in its application in the country caused a certain wariness among the co-founders of JSC *RLMS*, who were far from the technical side – representatives of banking capital, who were more inclined towards the tried and tested second. Therefore, the proposed A. A. Voronov's and L. V. Sventorzhetsky's version of the *KhLP* combined electrification scheme became, in fact, a compromise from a technical point of view, but hardly the cheapest - from a financial point, since it required both a special project and an individual set of equipment, which, moreover, could only be provided by electrical engineering firms at the same time with strong research and production bases. At the same time, the use of ready-made standard projects and sets of electrical equipment for them, without a doubt, is a cheaper way of electrification, which could be organized by less powerful electrical companies, and even electrical divisions of similar to Kharkov's machine-building plant, that we studding, – based on the projects they have already acquired for own electrification and their experience in the purchase, installation and operation of the corresponding complete equipment. That is, considering the preparation for the tender for the electrification of *KhLP* through the prism of different positions of the founders of JSC *RPMO* on the financial side of this issue², previous example of

² Although not reflected in the documents of the Board, but objectively taking place due to the investment essence of the project of creating the Company as a whole: by combining a private capital of the banking and industrial sectors of the economy, as well as attracting personal financial resources of major government officials.

Maschinenbau Schwartzkopf is not an incidental case, but was the result of attempts by certain circles in the Board of JSC *RLMS* to find a cheaper and at the same time more technically effective than proposed by A. A. Voronov and L. V. Sventorzhetsky, the option of electrifying his plant so that the interest of all the founders of the Society in it would allow revising the results of the competition even if such a project would be presented after it was held.

Meanwhile, all sorts of attempts to reach a financial compromise in the decision regarding the electrification of *KhLP*, carried out bypassing the technical compromise, were initially doomed to failure, because, as mentioned earlier, a sharp transition to full electrification of production according to the Western model in Russia at the end of the 19th century considered to be an excessively risky financial undertaking. And the basis for the formation of its opinion was not only the lack of experience in operating such systems, but also the complete absence of any current policy in the field of electrification of the country, or at least a vision of the foundations of such a policy in the future at the level of state management institutions, which forced financial circles of the empire to be very wary of the relevant investments of capital. Thus, the need to reach a compromise in the technical scheme for the electrification of *KhLP*, as a palliative, allowing, on the one hand, to avoid the possible, due to the long-term uncertainty of the object of financing, a departure from the latest concept of full electrification of the plant to partial electrification, which has already become normal practice in Russia³, and on the other hand, to preserve the possibility of a subsequent rapid transition to the Western model of electrification, was indisputable for all technically competent founders of JSC *RLMS* or their representatives on the Board. This, taking into account the low awareness of electrical engineering issues that existed then in the Russian Empire, even among the technical intelligentsia, as well as the level of the task being solved, which is quite difficult for a qualified assessment, made it possible to avoid significant influence of other points of view on organizing and conducting a competition for the electrification of *KhLP*, except as technically competent. That is, the organizers of this tender managed to exclude the possibility of consideration by the Board of JSC *RLMS* of any other projects except for the five firms officially admitted to the tender, despite the fact that, as the chronology of the relevant correspondence of JSC *RLMS* with other companies shows, attempts to start the course of events in a different way were made. However, only three companies: *Oerlikon*, *Siemens & Halske* and *AEG*, took full part in the competition, providing both detailed designs and reasonable cost estimates for products, materials and works. Although, it must be admitted that the preparation time for the competition was very short (one month), as a result of which costs estimates for the electrification of *KhLP* presented by *Lahmeyer* and *Hillairet* turned out to be incomplete, and *Hillairet's* project, moreover, turned out to be completed only in general terms (SAKhR: 1895m, 1896a). That is, initially only *Siemens & Halske*, which received information on the planned

³ Which was mentioned at the beginning of the article.

electrification of the JSC *RLMS* plant in Kharkiv long before the announcement of the competition in volumes sufficient to draw up the relevant preliminary design and estimates, had a guaranteed opportunity to provide design and estimate documentation of the required completeness within the deadlines established by the competition and quality. To do this, she only had to make changes according to the terms of reference of JSC *RLMS* in the existing calculations, and not start the design again, like all the other electrical companies participating in the tender.

In other words, the fact that *Oerlikon* and *AEG*, which are in much worse conditions than *Siemens & Halske*, nevertheless managed to properly prepare for the tender for the electrification of *KhLP*, indicates the high scientific and technical potential of these two companies, however, which was ignored by the Board of JSC *RLMS* during the competition itself. Thus, we have every reason to believe that not only the preparation for tender, but also the tender for the electrification of *KhLP* itself was held by the Board of JSC *RLMS* somewhat biased in favor of *Siemens & Halske*. So, for example, the total cost of electrification of the plant, proposed by *Oerlikon*, was only 1% higher than the cost proposed by *Siemens & Halske* [tab. 1], however, *Oerlikon* guaranteed the efficiency of the entire system of 75.27% versus 74% for *Siemens & Halske* (SAKhR, 1896c). That is, in case of winning the *Oerlikon* tender, having paid money to this company 1% more than *Siemens & Halske* disposably, JSC *RLMS* received 1.27% more useful capacity on the entire life of the *KhLP* electric power system. Nonetheless, the contract with *Oerlikon* was recognized as unprofitable, since, according to the conclusion of L. V. Sventorzhetsky in the project of this company, the efficiency loss in electrical wiring was 9% versus 3% for *Siemens & Halske*, and the overall high efficiency was achieved due to the high efficiency of the electric machines used (SAKhR, 1896d). Meanwhile, from an economic point of view, to assess the profitability of operating a production power supply system, its overall efficiency is important, and not its discrete value for individual elements of this system. Although, of course, from the technical side, the lower efficiency of the conductive elements in the *KhLP* electrification project presented by *Oerlikon* made it problematic a possible future increase in the power supply capacity of the plant on the existing electrical wiring due to a progressive drop in efficiency in this case, or even physical its inability to bear the applied load at a whole. However, on the other hand, *AEG*'s proposal, based on the preventive power reserve of the enterprise's power supply system [as we see in tab. 1], also did not find support from the Board of JSC *RLMS*, despite the fact that, in terms of a unit of capacity, the total cost of electrification of *KhLP*, proposed by *AEG*, amounted to 149 rubles. 68 kops. for 1 hp against 152 rubles. 78 kops. for 1 hp from *Siemens & Halske* [or 2% less]. That is, the management of JSC *RLMS* during the tender did not took into account [or took into account selectively] a possible increase in electricity consumption by its plant in the medium term, which makes the feasibility study of *Oerlikon*'s refusal to electrify *KhLP* very doubtful.

Table 1. Key indicators of cost estimates for *KhLP* electrification projects presented by competing firms [compiled according to: (SAKhR: 1896b, 1896c)].

Name of the firm-contractor	Power of an electric station (hp)	Total cost of electrification of <i>KhLP</i> (rub.)		Comments
		Originally stated	Changed during the competition	
<i>Hillairet</i>	900	94 726,00	94 726,00	The project is presented only in general terms; the estimate is given without taking into account the cost of delivery of components and their installation
<i>AEG</i>	1 200	197 856,04	179 610,00	In the project, instead of generators with a total capacity of 900 hp, generators with a total capacity of 1,200 hp are included, and the cross-sections of the wires of the power grid are not indicated.
<i>Siemens & Halske</i>	900	154 730,00	137 500,00	Without comments
<i>Oerlikon</i>	900	138 874,00	138 874,00	Project and estimate are not detailed enough
<i>Lahmeyer</i>	900	132 054,00	132 054,00	The estimate does not take into account materials that the company was supposed to purchase in Russia

Moreover, a similar refusal to *AEG* is also puzzling, since just replacing the power generating unit proposed by this company with a unit of the same capacity as that of *Siemens & Halske* or *Oerlikon* could reduce the final cost of electrification of *KhLP* under the *AEG* project at least to the cost proposed by *Siemens & Halske*, with

an efficiency equal to the guaranteed *Oerlikon* and keeping of electrical wiring, allowed without any significant loss in it, the efficiency of the system as a whole, if necessary, to increase the power of the latter by a third. In spite of all the above, the Board of JSC *RLMS* did not proposed *AEG* to revise its project in the direction of reducing the power generating unit, which, in principle, would not have taken many times for the company's engineers, given that they completed the full project in month. Moreover, the design competition was held on January 19, 1896, when the snowy and frosty winter in Kharkov forced the suspension of all construction work at the *KhLP* until the end of April of this year, and the design of the power station by the architect of the plant A.I. von Goghen was carried out almost last, which, however, was due to the objective necessity of the initial design of production areas (SAKhR: 1896e, 1896f).

Thus, there is every reason to believe that the victory of *Siemens & Halske* in the tender for the electrification of *KhLP* was not due to the technical and economic advantages of the corresponding project presented by this company over the projects of its competitors, although its high scientific and technical level cannot be denied. The presence of other reasons for this victory allows us to consider both the previously indicated facts regarding the leakage of confidential profile information from the Board of JSC *RLMS* in favor of *Siemens & Halske*, and the fact sanctioned by the Board a personal meeting of its Chairman Viktor Mikhailovich Ivanov (1846–1919) with a representative of *Siemens & Halske* in St. Petersburg, which took place approximately 10 days before the tender, at which, as follows from the minutes of the Board meeting, there was a discussion about reducing the originally announced by *Siemens & Halske* cost of electrification of *KhLP* (SAKhR, 1896b). It is embarrassing as that the meeting was initiated by this representative, both that all such discussions with representatives of other firms participating in the competition were carried out by correspondence. Personal meetings on business matters with the management of the Board of JSC *RLMS* were not initiated either by the Board itself or by other competing companies, despite the presence of their authorized representative offices in St. Petersburg [at least, there are no corresponding mentions in the documents of JSC *RLMS*]. This exclusion in relations with the contestants, made for *Siemens & Halske*, chronologically coincides with the beginning of preparations for the creation of JSC *Russian Electrotechnical Plants Siemens & Halske* [Highly approved in 1898] with the proposed construction of a parent enterprise in St. Petersburg and a network of small electrical plants, the geographical location of which was to correspond as closely as possible to the centers of the areas of greatest consumption of *Siemens Corporation* products and services. The rest of the tender participants, at the time of its holding, did not raise the issue of creating their own plants on the territory of the Russian Empire, while the plant of another division of *Siemens Corporation* – *Siemens-Schuckertwerke* had been operating in St. Petersburg already for more than 40 years, which made intentions in 1895 regarding the creation of the above joint-stock company entirely real. Taking into account the “protectionist policy” being pursued by the tsarist government at the same time, as well as the fact that high-ranking government officials were present among the

leadership of the Board of the JSC *RLMS* [such as, for example, an official for special assignments under the Minister of the Imperial Court N. N. Koksharov was one of the directors of the Management Board and General V.M. Ivanov was its Chairman], and the fact that both profile experts of JSC *RLMS*: and A. A. Voronov, and L. V. Sventorzhetsky were real state servants [and the latter, moreover, an officer], we get a reason to make an assumption about a more meaningful conversation between the Chairman of the Board of JSC *RLMS* and a representative of *Siemens & Halske* than was displayed in the minutes, and which was carried out taking into account the state interests of the Russian Empire. And the incompleteness of information about it in the protocol wording, in this case, may well be due to the need to keep the competitive secret of its counterparties, especially since the process of creating *Siemens & Halske Russian Electrotechnical Plants* JSC at the time of the tender was in the phase when the corresponding the decision by the management of *Siemens Corporation* had already been made, but its implementation is still being prepared.

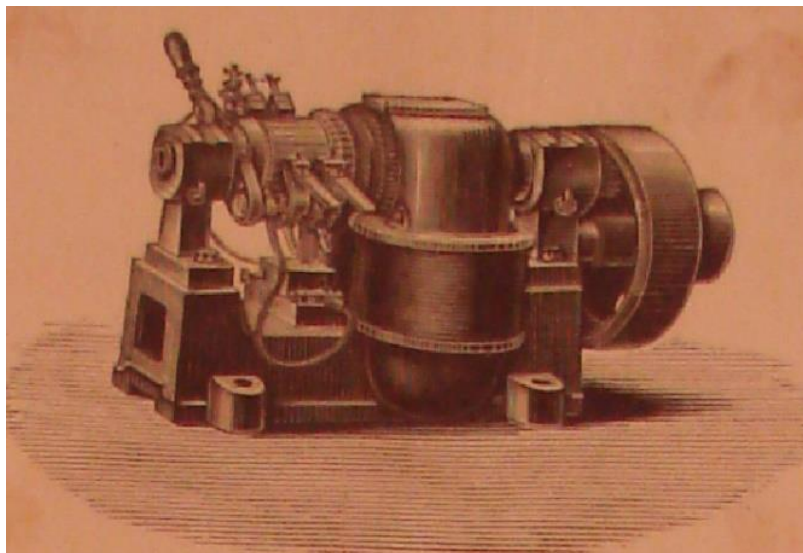


Figure 5. Siemens N-type electric motors with power from 1 hp to 60.5 hp, installed since 1896 for metal-cutting machines manufactured by KhLP (SAKhR, 1896k).

That is, we can say that the victory of *Siemens & Halske* in the tender for the electrification of *KhLP*, with rather dubious technical and economic advantages of the project presented by it, could with a high degree of probability be the result of strategic agreements between this company and JSC *RLMS* about the further cooperation in context of the “protectionism policy” pursued in the country, what kept secret from *Siemens*’s competitors. We find indirect confirmation of this in almost simultaneously with this victory [a month later] the emergence in JSC *RPMO* of a project to organize a joint production of electric locomotives with *Siemens & Halske* at the same *KhLP*, however, not implemented both due to a lack of free production capacities at the plant, and because of the small current demand for them in the domestic market of the empire (SAKhR, 1896g). However, the fact that this project of the AO *RLMS* was considered

seriously is evidenced by the fact that from May 1896 L. V. Sventorzhetsky as Society's expert had on a three-month trip abroad in order to get acquainted with the practice of electric locomotive construction at foreign electrical plants (SAKhR, 1896h). Also, an indirect confirmation of the existence of strategic agreements on further cooperation between *Siemens & Halske* and JSC *RLMS* even before the tender for the electrification of the *KhLP* was held is that, starting from December 1, 1896 [that is, even before the completion constructing works on the plant] machine tools according to the drawings of *Usines Bouheu*, those that manufactured with an individual electric drive, was equipped with electrical equipment exclusively by *Siemens & Halske*, and not by specified in the original technical documentation - for the most part by French electrical companies (SAKhR: 1896j, 1897c). At the same time, the discount in the price for this electrical equipment, provided by *Siemens & Halske* to JSC *RLMS*, ranged from 15% to 20% of its minimum price in free sale on the domestic market of the Russian Empire (SAKhR, 1897c).

Discussion.

The statements given in the presented material are largely based on assumptions, which is due both to the small number of documents that have survived today in Ukraine regarding the issue under consideration, and the practice of verbal agreements inherent in business on the most confidential aspects of partnerships. However, all the assumptions are made on the basis of the imperatives of the theory and practice of mechanical engineering technology, as well as the theoretical foundations of electrical engineering, applied in accordance with the principles of historicism, which allows us to consider the presented historical picture of the organization of the preparation of the *KhLP* electrification process at the stage of creating the plant as an objective picture at a whole. At the same time, the authors admit the possibility of further identification of additional historical facts that specify the role of individual individuals or legal entities in solving the issue considered in this article – both already known and newly established. Also, taking into account the volume and geography of the corresponding correspondence of the JSC *RLMS*, the authors do not exclude the entry into scientific circulation of new documents on the topic they studied. However, the probability that the information contained in these documents in its general meaning will contradict the already established one remains extremely low, if only because of the limits of the semantic variability of the information necessary for JSC *RLMS* on the organizational preparation of the *KhLP* electrification process, which have already been finally clarified, and examples filling in the information field in which are already given.

Conclusions.

The electrification of the *KhLP* became a significant event that determined the further path of development of the industry not only in the Ukrainian territories of Tsarist Russia, and not only in the empire as a whole, but also in Ukraine and the Soviet Union, because that choice of the scheme for organizing production processes, which

was made due to objective and subjective circumstances in its implementation has been made for the first time within the territorial boundaries under consideration, and subsequently was used massively and constantly [albeit with varying degrees of success], despite the changes in socio-economic relations and political-social structures that took place within them. Thus, the experience of electrification of the *KhLP* is successful, which, considering it as a major innovative event, allows us to once again be convinced of the unambiguous effectiveness of such events only when they are carried out simultaneously with the introduction of a set of other innovations that make it possible to use the most of the advantages to be acquired. At the same time, the organizational preparation for the electrification of *KhLP* had certain nuances that led to both positive and negative consequences for the further operation of the enterprise, including in terms of establishing the practice of making compromise decisions by the relevant management on issues that were controversial only due to technical incompetence leading staff. Thus, due to lobbying by one part of the Board members of the JSC *RLMS* of the interests of only one participant in the tender for the electrification of *KhLP* – *Siemens & Halske* and the technical incompetence of its other part, the applied electrification scheme of the enterprise under study turned out to be not the cheapest in execution and obsolete already at the time implementation, which later led to its radical alteration at an already operating plant. However, on the other hand, cooperation between JSC *RLMS* and *Siemens & Halske* has become one of the factors contributing to the development of the electrical industry in the country, moreover, on the basis of scientific and technical experience and material resources of one of the world's best manufacturers of electrical equipment. In addition, this manifestation of the “protectionist policy” served as one of the brightest examples for other leading world manufacturers of electrical engineering in terms of demonstrating the opportunities that open up for them in the market of the Russian Empire if enterprises of the corresponding profile are organized in it.

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Conflicts of interest.

The authors declare no conflict of interest.

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Нюанси організаційної підготовки електрифікації Харківського заводу Російського паровозобудівного і механічного товариства (1895–1896 гг.)

Анотація. *Перехід до електромеханічного приводу устаткування став новою віхою в індустріалізації, що привела до значного: зростання продуктивності праці та зниження енергоємності виробничих процесів. Але на українських землях Російської імперії дана інновація до середини 1890-х років не впроваджувалася, і лише саме з того часу процес електрифікації виробництва на українських підприємствах отримав свій розвиток, проте при цьому на них зберігався й паромеханічний привод обладнання. Харківський завод Акціонерного товариства «Російське паровозобудівне і механічне товариство» став першим підприємством не лише в українських губерніях Російської імперії, але й у всій країні, на якому було застосовано виключно електромеханічний привод усього устаткування. Зважаючи на даний пріоритет, організаційна підготовка процесу електрифікації цього підприємства також стала першим у країні досвідом впровадження такої інновації, порівняний бодай лише з досвідом переходу з механічного на паромеханічний привод, який, однак, у Російській імперії не був досліджений. При цьому, рівень технічної компетенції частини керівництва Акціонерного товариства «Російське паровозобудівне і механічне товариство» був недостатньо високим для того, щоб надавати адекватну техніко-економічну оцінку відповідним інноваціям. Через це організаційна підготовка електрифікації Харківського заводу означеного Товариства проводилася без яких-небудь чітких методологічних підходів, яка у дискусії щодо*

схеми електрифікації підприємства привела до заміни питання вибору оптимального варіанту з ефективних питань вибору оптимального з дешевих. В результаті, експертами Товариства було розроблено технічне завдання на компромісний варіант проєкту електрифікації, суть якого полягала у встановленні відносно нового за технічним рівнем електрообладнання, що експлуатувався по вже застарілій схемі, це робило даний варіант електрифікації ані ефективним ані дешевим, але політично проблемним для усього керівництва Товариства. Досягти очікуваної вигоди від електрифікації заводу в результаті вдалося не від запровадження обраної схеми її проведення, а шляхом укладання стратегічних домовленостей із компанією Siemens & Halske, згідно з якими Правління Товариства забезпечило їй перемогу в конкурсі на електрифікацію свого підприємства за прийнятною ціною, а Siemens & Halske, в свою чергу, в подальшому постачало свою продукцію із значними знижками.

Ключові слова: електропривод; електромеханіка; індустріалізація; інновації; машинобудування; виробничі процеси

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From panchuran to waterleiding: clean water solutions in Colonial Bandung, West Java, Dutch East Indies (1898–1934)

Abstract. *This study examines clean water management in Bandung, West Java, Dutch East Indies (Indonesia), from the late 19th Century to the early 20th Century. This study focuses on how the human community has modified the physical water unit, including technology, management skills, and social and environmental priorities. Historical methods were applied to investigate the topic, including heuristics, verification, interpretation, and historiography. Most of the data in this study were collected from primary sources in the form of archives, and official documents Department of Public Works and Bandung Municipality Government published in the late 19th century to the first half of the 20th century. The results showed that indigenous people in Bandung, the Sundanese, manage springs and rivers based on local knowledge, harmonizing simple technology with nature and belief. They used panchuran, a channel made of bamboo strips, to drain water from the springs. While Europeans initially relied on dug wells for daily water needs in the late 19th Century. However, concerns over epidemics and rapid population growth in the early 20th Century led to more well-planned, professional water management supported by science and technology-based infrastructure. The Bandung municipality government mobilized engineers and scientists to research new water sources and build clean water infrastructure. By the 1930s, they could build artesian wells, waterleiding networks, reservoirs, filtration systems, and clean water public facilities. Bandung municipality government exploited clean water resources that expanded from urban to mountainous areas north of Bandung. The municipality government recognized that clean water resources needed to be explored and capitalized. Two clean water services were available in Bandung: a pipeline service that delivered water directly to households and accessible public facilities. Indigenous people in Kampongs used public facilities, while Europeans used paid pipeline services.*

Keywords: *clean water; waterborne diseases; infrastructure; technology; environmental history; Bandung*

Introduction.

Water is commonly associated as the source of life. The world's greatest civilizations have flourished due to their adjacency to water sources. Water is a common element of Jewish, Christian, and Muslim rituals; water becomes a marker of cleanliness and purity. While water is essential to sustain human life, history has shown that it can lead to devastating consequences. A tragic example of this occurred in 1854 due to the consumption of water contaminated with sewage from a water pipe in Soho, London; as many as 600 individuals lost their lives within one week (Snow, 1857). As a result of this event, the danger of spreading waterborne diseases began to be known. Many casualties were caused by the supply of water polluted with bacteria (*vibrio*

cholerae) did not occur partially but also spread in Europe and North America around the 19th Century (Baldwin, 2009; Briggs, 1961).

Similar conditions have occurred in colonies such as the Dutch East Indies (Indonesia). The spread of cholera outbreaks once hit Java and Madura Island in the early 20th Century (Nasihin, 2021; Tillema-Weehuizen & Tillema, 1919). According to Tuyter (1930), an unhygienic habit and difficult access to clean water caused tropical diseases in the Dutch East Indies, such as hookworms, dysentery, typhoid, and cholera. From the colonial government's perspective, the poor habits of indigenous people in *kampongs* (a hamlet or village) and the threat of plague were thought to hamper the pace of the industry and the economy in cities in the early 20th Century (Jaelani, 2017; Naas, 2007). For this reason, preventive efforts are needed in the form of environmental improvement and the provision of clean water by utilizing urban technologies (Ravesteijn, 2007).

In addition to sewage and flood management facilities, providing clean water infrastructure was an essential element that the municipality government (*gemeente*) was trying to realize in the Dutch East Indies. The availability of clean water can suppress the spread of diarrhea, typhus, dysentery, and cholera in the Dutch East Indies (Van Loghem, 1920; Mom, 1931). Therefore, at the beginning of the 20th Century, municipality governments such as Batavia, Semarang, Surabaya, Medan, and Bandung began to carry out extensive construction for the provision of clean water through artesian wells (*artesische putten*) and pipelines (*waterleiding*) (Paulus, 1917, pp. 62–64). Clean water and infrastructure built by the government were essential to creating a healthier and more prosperous population following ethical politic agendas. The production of clean water infrastructure in the early 20th Century has proven to be a lasting legacy of colonial heritage, particularly in major cities in Indonesia (Kooy & Bakker, 2014; Ravesteijn, 2007).

This study investigates the pioneering efforts of the municipal government in the Dutch East Indies (Indonesia) to establish clean water infrastructure during the late 19th to early 20th centuries, focusing on the local context of Bandung, West Java, Indonesia. The selection of Bandung as the subject of analysis was based on its significance in clean water management during the colonial period, owing to several crucial factors.

First, Bandung is an area that was shaped by the ancient Sunda Mountain caldera. The land lies near four active volcanoes: Tangkuban Parahu, Salak, Galunggung, and Guntur. The geographical characteristics of Bandung are generally associated with fertile land and abundant water sources (Van Bemmelen, 1934). A large number of water sources is also indicated by 295 toponyms of places in Bandung related to water (Kulsum, Sutini, Harijatiwidjaja, Saptarini, & Mulyanah, 2008). Second, Bandung was once designated by Governor General Van Limburg Strirum as a candidate for the Dutch East Indies administrative center to replace Batavia in 1917. Several important departments began to be moved to Bandung in the 1920s, including the Department of Transportation and Waterworks (*Departement van Verkeer en Waterstaats*)

(Roosmalen, 2008). During the early 20th Century, Bandung had institutions, such as the Bandung Technical High School (*Technische Hoogeschool te Bandoeng*), the Geological Laboratorium (*Geologisch Laboratory*), and the Pasteur Institute, which facilitated research and innovation in the field of clean water resources.

Given these factors, it is possible that Bandung had a well-planned clean water infrastructure and governance during the early 20th Century. This study validates this hypothesis by examining Bandung's clean water management. The study sheds light on the pattern of clean water management in one of the prominent cities in the Dutch East Indies, providing insights for future studies.

The study of clean water is not new in the historiography of the colonial period, especially in Southeast Asia and Indonesia. Yeoh (1993) conducted a similar study, discussing Singapore's sanitation reform and clean water networks. Taylor (2013) discusses the concept of cleanliness and the practice of bathing in the daily livelihoods of the Dutch and indigenous people in the Dutch East Indies. Kooy and Bakker (2014) explore Batavia's piped water network through a postcolonial lens, seeing piped water as a colonial heritage. Andaya (2018) discusses the various approaches that can be used to study water in the Southeast Asian region. In a more local scope, research has also been carried out on improving the political system and clean water governance in Surabaya (Achdian, 2020), sanitation problems in Medan (Affandi, Agustono, & Zuska, 2022), and the construction of water pipelines in the context of the historical trajectory of modernization in Yogyakarta, Surakarta, Surabaya, and Batavia in the early 20th Century (Primaditya, 2022).

A previous study that is quite intersected with the locus of this study is the result of Budiman's (2022), which discusses the *Development of Sanitation and Hygiene Infrastructure in Bandung in the Early 20th Century*. The study discusses clean water sources, household waste management, and waste management in the context of hygiene. However, the study has only examined clean water sources and their distribution. That study has no depth discussion about exploration, technology, and clean water management. For this reason, this study was to deepen the study conducted by Budiman (2022) through the lens of anthropogenic changes in the water system proposed by Tvedt (2010). Anthropogenic changes in this study are the modification or management of physical water units by human communities, such as the construction of dams, canals, reservoirs, ponds, and wells that can affect the physical aspects of water and the culture of local communities (Tvedt, 2010). The water in this study does not include urban drainage management, flooding problems, or irrigation water in an agricultural context. This study contains water sources in the freshwater domain: river water, groundwater, and springs used for drinking, bathing, and daily household needs.

Research method.

This study uses the historical method to reconstruct past events. The historical method consists of four steps: heuristics, verification, interpretation, and

historiography (Gottschalk, 1969). At the heuristic stage, we collected primary textual sources, including the annual report of the Department of Public Works (*Burgerlijke Openbare Werken*) from the end of the 19th Century to the first decade of the 20th Century, the report on the condition of the Municipality of Bandung (*Verslag van den Toestand der Gemeente Bandoeng*) 1906–1918, the piped water report of the Bandung Municipality (*Waterleiding Rapport Gemeente Bandoeng*) 1924, hygienic brochure of Bandung and its surroundings (*De Hygiene in Bandoeng en omstreken*), civil engineering journals (*De Ingenieur, Locale Techniek*), newspapers and magazines (*Algemeen Indisch Dagblad, Bataviaasch Nieuwsblad, De Locomotief, Het nieuws van den dag voor Nederlandsch-Indië, Mooi Bandoeng*), and encyclopedia of the Dutch East Indies (*Encyclopedie van Netherland Indie*). In addition to primary sources from the 19th and 20th centuries, we use secondary sources, including dissertations and up-to-date journal articles.

After the collection of sources, we conduct the criticism stage, which is the stage of verifying the sources. After verification of the sources, the step carried out is interpretation. A thorough reading of the textual source is required to obtain an interpretive examination of social phenomena (*verstehen*). At this stage, the reading process is carried out by bringing perspective on anthropogenic changes in the approach of the water system. The final step is historiography; The facts of the reading are then arranged systematically based on a frame of mind and time sequence to present a complete historical narrative.

Result and discussion.

Bandung, located in the hinterland of West Java, can be classified as a mountainous region with an elevation of 2,300 feet above sea level. This area was surrounded by mountains, nourished by rivers, and boasted fertile soil (Coolsma, 1879; Forbes, 1885). Bandung's basin area was previously a prehistoric lake that desiccated, resulting in the region being endowed with numerous water sources and marshy zones (Forbes, 1885, p. 107; Hardjasaputra, 2002). As one of the important cities in West Java, Bandung is traversed by two major rivers, Citarum and Cikapundung. The city, which Regent Wiranatakusumah II founded in 1810, is also traversed by small rivers such as the Ciguriang River on the west side and the Cikawao River on the east side (Kunto, 1986; Yusandi, 2022). Four volcanoes surround Bandung: Tangkuban Parahu, Salak, Galunggung, and Guntur (Van Bemmelen, 1934). Foreign travelers who visited Bandung in the past were often captivated by the region's natural splendor, which presented an idyllic vision of the Dutch East Indies in the form of expansive plantations, picturesque mountains, cascading waterfalls, and refreshingly cool air (Reitsma & Hoogland, 1927).

Significance of water in the establishment of Bandung.

The precursor to the city was established in the southwest of the Cikapundung River and comprised the regent's house, pavilion, square, and mosque, which were built

near the Post Road (*De Groote Postweg*). During its early years, Bandung was a forested area that gradually developed into a village in the hinterland of West Java. North of Post Road, several old *kampongs* (a hamlet or villages) stood: Balubur, Cikalintu, Gadog, Dago, Gegerkalong Girang, and Babakan Bogor (Hardjasaputra, 2002; Kunto, 1986).

The selection of the locations for the old *kampongs* in the Bandung area was heavily influenced by a mythic-spiritual element that prioritized water as a primary consideration. Furthermore, the positioning of the *kampongs* and the city center (*alun-alun*) was guided by the principle of "*garuda ngupluk, tanah hade, bahe ngaler-ngetan, deukeut pangguyangan badak putih*" (the location of land resembling the flapping wings of the mythical bird Garuda, fertile soil, sloping towards the northeast, and adjacent to the place where the white rhinoceros wallows) (Affandie, 1969, p. 6; Kunto, 1986, p. 397). The term "*pangguyangan badak putih*" (the place where the white rhinoceros wallows) is an analogy to a place rich in sources of water.

According to Kunto (1986) and Tillema (1915), it can be seen those old *kampongs* in Bandung were located close to springs, such as *Kampung Cikalintu*, which is adjacent to the "*Pancuran Tujuh*" spring in Cikendi, *kampung Bogor* was adjacent to Ciguriang spring. *Kampung Balubur* was adjacent to Balubur Spring. The city center (*alun-alun*) was close to the water source known as Bandung Well (Tillema, 1915). The origin of Bandung Well is mythologized as a source of gushing water because of the stick that Wiranatakusumah II stuck when he visited the location of the precursor of the city (Akhmad, 2021).

The Sundanese people in Priangan, West Java, were accustomed to living amid nature abundant with water. They rarely experience a lack of water for drinking and bathing; almost every house has its pond (Coolisma, 1879). The main livelihood of the Sundanes community, including the people of Bandung, was cultivating fields and rice fields that required a lot of water supply (Drewes, 2013).

Most of the inhabitants of Bandung in the early 19th Century were *cacah*; commoners who worked to cultivate agricultural land, raise livestock, and make various tools (Coolisma, 1879; Hardjasaputra, 2002). They lived simply in a stilt house (*imah tjeblok*) with its simple sanitation; utilizing the water of the Cikapundung River (Kunto, 1986). This kind of population was characteristic of the rural population.

According to Hardjasaputra (2002, p. 53), Bandung in 1825 was more like a village with a traditional order characterized by town squares, pavilions, a mosque, and a hall known as *Bale Bandung*. The road conditions were covered with gravel stones and muddy in case of rain. There were few permanent buildings, such as residential lodges, military barracks, and inns (Hardjasaputra, 2002, p. 57). Until 1846 the city's growth was slow. The number of inhabitants was not too much: 11,000 Indigenous, 13 Chinese, 30 Arabs, and 9 Europeans (Himpoenan Soedara, 1936, p. 5).

Bandung's growth accelerated in 1862 when the Priangan (West Java) Governor's office was relocated from Cianjur to Bandung. The city's rapid development was also driven by several other factors, including the construction of the western railway line,

the establishment of railway workshops, and the establishment of the War Department in the 1880s (Drewes, 2013). The enactment of the Agrarian Law in 1870 caused many European business people to arrive and open companies in Bandung. European employees and professionals came to Bandung to build a new life. At the same time, there was a process of moving indigenous residents from villages to find jobs and live in cities (Reerink, 2015). By 1890, the population was already much larger: 16,656 Indigenous, 991 Arab, and Chinese, and 467 European (Himpoenan Soedara, 1936, p. 6).

By the end of the 19th Century, Bandung had transformed into a complex colonial city. The Priangan Governor had the power to determine urban design policies; the indigenous group had its local government, while settlements were organically segmented by race and ethnicity (Hardjasaputra, 2002; Naas, 2007). The indigenous people tended to build *kampongs* scattered to the south and east of the Post Road, and the Chinese and Arabs settled around the markets to the west of the city. The Europeans built settlements and centers of activity next to the Post Road, leading to the Lembang plateau. At this point, the formation of the city raises problems: adequate clean water according to population growth and efforts to overcome the outbreak that was prevalent in the Dutch East Indies in the 19th Century (Jaelani, 2017).

Clean water sources in the 19th century.

For indigenous residents, especially the Sundanese people, clean water sources were obtained and managed based on local knowledge (Lombard, 1996). The spring (*seke*) was sacred and associated with the spirit, gods, and ancestors (Hoogland, 1937; Wessing, 1988). This spring that was considered sacred can be found in folklore, such as the story of Nyi Mas Katrimanik. This spring that was regarded as sacred also can be found in the lore of the Wiranatakusumah II stick that can spouts spring water; and the well-waiting ghost (*jurig*) in the folklore of *Roesdi jeung Misnem* (Akhmad, 2021; Deenik & Djajadiredja, 1930; Hoogland, 1937). Sumardjo (2019), in his research on Sundanese cultural artifacts, mentions that spring water is symbolized as something sacred; it is far upstream, close to the "upper world," close to the gods and spirits of the ancestors (Sumardjo, 2019).

The sacred water sources can be related to prohibition forests (*hutan larangan*), where springs and various vegetation can be sustained without disrupting human hands (Prestasi & Kim, 2020; Wessing, 1988). The sacred of these springs allows for clean water sources and circular water management. Upstream is a clean water source; in villages, water is used for rice fields. While downstream, water is used for sewage and fish ponds. Nevertheless, this pattern is applied in rural environments that are still close to nature, not for the type of urban environment that is more complicated in the layout of the settlement.

According to the *Encyclopaedie van Nederlandsch Indie*, people living in mountainous areas like Bandung and the west Java hinterland—the Sundanese—use natural springs from rocks to access clean and fresh water (Lith, Spaan, & Fokkens,

1900b). The indigenous use bamboo to collect water from the seepage between the rocks. The bamboo was placed at an angle to allow the water to flow slowly and steadily onto it. This simple technology was called *pantjoeran* (Lith, Spaan, & Fokkens, 1900b, p. 471). In the Sundanese dictionary, the term *pantjoeran* or *panchuran* refers to a fixed and unmovable spout, channel, gutter, or bamboo piece used for directing water and even as a spout for bathing purposes. This word's etymology can be traced back to "*chur*," meaning to flow out (Rigg, 1862, p. 342).



Figure 1. KITLV 11902, Two women washed clothes near the Cikendi spring, Bandung. Water from the spring flows through *panchurans* (KITLV, 1920a).

The Sundanese collect water from the *panchuran* and filter it using a cone-shaped tuff vessel suspended within a wooden frame. The filtered water drips into a *tempayan* (crockpot), where it is collected. (Lith, Spaan, & Fokkens, 1900b). If the crockpot is left outside the house at night, it can help to cool down the collected water (Lith, Spaan & Fokkens, 1900b). In Bandung, the Sundanese refer to the crockpot as "*kendi*." Interestingly, the word "*kendi*" is also associated with a toponym called "*Cikendi*," one of the springs in the northern part of Bandung (Van Bemmelen, 1934; Gemeente Bandoeng, 1924). The name "*Cikendi*" originated from the indigenous practice of using a *kendi* to collect water from the *panchuran*.

Panchuran was commonly used to drain springs in the 19th Century (Kolff, 1880; Lith, Spaan, & Fokkens, 1900b). In addition to obtaining clean water from *panchuran*, the indigenous inhabitants utilized the clear waters of the Cikapundung River for their daily needs, including bathing, washing clothes, and even defecating (Kunto, 1986;

Tillema, 1915). This habit of using surface water became one of the reasons for the spread of cholera and typhoid in the Dutch East Indies (Van Loghem, 1920; Tuyter, 1930).

Unlike some regions in Java, such as Pasuruan, Tegal, Banyumas, Madura, Surabaya, Batavia, and Tangerang, Bandung was never afflicted by a significant cholera outbreak during the 19th Century (De Volksziekten in Nederlandsch Indie, 1877). Based on news in the *Haagsche Courant*, cholera in Bandung occurred in 1891 and killed a resident named Heitjing (Baranoerie, 1891). Likely, cholera cases in Bandung at the end of the 19th Century were sporadic and isolated. That condition can be attributed to Bandung's access to multiple sources of clean water from springs and surface water, which were not contaminated with sewage, thus minimizing the risk of cholera outbreaks (Tillema, 1915). Moreover, by the end of the 19th Century, the indigenous population had already adopted boiling water (known as "*njaneut cai*") to eliminate bacteria, further contributing to preventing waterborne diseases like cholera (Anoniem, 1894; Coolsma, 1879).

Despite the existing preventive measures, access to adequate clean water remained a pressing issue as the population grew and the city became a more modernized urban center. European settlers in the Dutch East Indies during the 19th Century were knowledgeable about water hygiene standards. They preferred to use water from a well instead of a river. However, the use of well water was limited to individual households. The water quality in these wells was highly dependent on the soil condition and the depth of the well, which meant that not all soils could provide a safe source of drinking water (Bergmans, 1909, p. 89).

In 1898, the Drinking Water Supply Division, which operated under the Department of Waterworks (*Waterstaatswerken*), initiated efforts to excavate artesian wells in Bandung by the Government Regulation No.4 dated May 10, 1883 (Burgerlijke Openbare Werken, 1902). The location for the excavation of the artesian well was selected by the Director of Education, Religion, and Industry in consultation with Governor Priangan, West Java (De Locomotief, 1898).

Artesian wells were somewhat different from ordinary dug wells that were used individually. Governor-General permission was required for digging artesian wells deeper than 35 meters (Lith, Spaan, & Fokkens, 1900, p. 46). Artesian wells can reach depths of over 700 meters, providing clean water less prone to bacterial contamination. The water from artesian wells was usually more abundant in areas around volcanoes. The Mining Department carried out geological surveys of artesian water sources in the Dutch East Indies. The drilling methods used were twist-flushing and ramming-flushing (Paulus, 1917).

Artesian wells were excavated in five locations in Bandung: Tegalega Indigenous School (72 meters deep, 400 liters/minute flow rate), a well near the Bandung Post Office (67.75 meters deep, 715 liters/minute flow rate), near the house of the Priangan Governor (61.2 meters deep, 460 liters/minute flow rate), north of the Chinese Temple, and at the Cimahi Military Camp (Burgerlijke Openbare Werken, 1898, p. 134).

Efforts to explore new water sources continue by the Waterworks Department. Still, excavations often experience technical obstacles, such as drilling hampered by large rocks resulting in personnel injuries (Burgerlijke Openbare Werken, 1899). The process of exploring water sources in Bandung faces not only technical challenges but also financial constraints. As the region has not yet achieved autonomy, the available funding depends solely on the central government of the Dutch East Indies. Investigations into water hardness levels often require the participation of private parties, such as researchers from the Quinine Bandung Company (Burgerlijke Openbare Werken, 1902). Despite limited funding, the Waterworks Department successfully discovered five artesian wells by 1901. These wells included those in Tegalega (250 liters/minute), the Post Office (660 liters/minute), the Priangan Governor's house (670 liters/minute), Citepus (1550 liters/minute), and Oud Medika (2700 liters/minute) (Burgerlijke Openbare Werken, 1901). The clean water from these five artesian wells was made available to the residents of Bandung for free (Algemeen Indisch Dagblad, 1931c).



Figure 2. KITLV 110991, Illustration of a *tukang angkut air* in Java in 1900 (Van der Heyden, 1900).

European residents in Bandung obtained their clean water supply from the artesian wells with a *tukang angkut air* (water carrier) that delivered water to their households. Unfortunately, these *tukang angkut air* typically used old oil cans to transport the water, which posed a significant risk to the cleanliness of the water supply (Figure 2). Each *tukang angkut air* could transport two cans of water (36 liters total), with each liter being sold at a price ranging from 0.15 to 0.25 guilders per liter (Algemeen Indisch

Dagblad, 1931c; Van der Heyden, 1900). Meanwhile, for indigenous residents, clean water sources from artesian wells do not entirely change the habit of still using the river and spring for bathing and washing clothes (Tillema, 1915).

Clean water solutions in the early 20th century.

At the beginning of the 20th Century, Bandung became more autonomous and modern. In 1906 the status of Bandung changed to the *Gemeente* (municipality), with the management of the city in the hands of a city council dominated by Europeans (Himpoenan Soedara, 1936). Bandung grew rapidly with rail transportation, shopping centers, hotels, schools, and new settlements for Europeans (Hardjasaputra, 2002; Kunto, 1986; Voskuil, 2017). By 1906, the population of Bandung consisted of 2199 Europeans, 3799 Foreign Easterners, and 41393 indigenous residents. (Himpoenan Soedara, 1936). As was typical in colonial cities, the development and management of urban infrastructure, including hygiene and clean water supply, were often determined according to a relatively small group of Europeans' interests (Bandoeng, 1929). On the other hand, indigenous people in *Kampongs* have their standard of living and local government, which is often difficult for the municipality to intervene directly (Reerink, 2015).

Indigenous settlements' low cleanliness level became a real threat in the early 20th Century (Bandoeng, 1929; Tillema, 1915). Cholera cases frequently occur in *kampongs*, as reported in *Het nieuws van den dag voor Nederlandsch-Indië* (Cholera te Bandoeng, 1913). Cholera cases have been found in several *kampongs*: Tegalega, Citepus, Regol, Cikakak, Cibeunying, Cisondari, Ujungberung, and Cipatat. Some cases of cholera cause fatalities, and others only cause sufferers to be taken to the hospital (Cholera te Bandoeng, 1913). Due to the frequent occurrence of residents affected by cholera, *Gemeente* Bandung formed cholera brigades in charge of providing health counseling to residents. However, due to rumors of kidnapping and not establishing good communication with the indigenous, the arrival of the cholera brigade to *Kampong* Kebonjeruk caused clashes with indigenous residents and caused the death of two policemen (Cholera-Opstootje te Bandoeng, 1909; Kunto, 1996, p. 52).

Since the incident, *Gemeente* Bandung began to take more preventive and severe efforts to prevent the spread of cholera in Bandung. One of the steps was to realize access to clean water for the community. In 1910, *Gemeente* Bandung poured funds of 85,000 guilders to build a clean water pipeline network (*waterleiding*) in the East Bandung area. The pipeline was connected to the artesian well in Oud Merdika and the new artesian well in *Kampong* Balubur (Bandoeng, 1929). The water pipeline was designed by a civil engineering agency called Nierstrasz (Tillema, 1915, p. 103). Construction of the first water pipeline was completed in 1911, and the pipeline network was used by 100 customers (Algemeen Indisch Dagblad, 1931c). In 1912 the construction of pipelines continued with 200 pipeline connections to customers'

households. The profit in that year reached 4200 guilders (Gemeente Bandoeng, 1919, p. 28).

In 1913, the *Gemeente Bandung* invested 150,000 guilders in expanding the pipeline network, which extended to the West Bandung area (Bandoeng, 1929). Until 1915, Bandung had seven artesian wells in Dago, Oud Merdika, Pasirkaliki, Citepus, Cicendo, Balubur, and old wells near Post Road (Tillema, 1915, p. 103). These seven artesian wells were Bandung's primary source of clean water. However, the existing pipeline network can only cover 550 customers, including hotels, markets, and schools. Not all available pipelines were connected to artesian wells. Few artesian wells have pipelines, so most residents must use *tukang angkut air* (water carrier) services.

Meanwhile, indigenous residents with low economic ability must collect water directly from available artesian wells, rivers, or natural springs in the highlands of Bandung. Sometimes, indigenous residents use leaking water pipes to get clean water, even bathing at the location of the leaky pipe (Tillema, 1915). This condition illustrates the uneven access to clean water, so *Gemeente Bandung* took the initiative to provide additional clean water facilities for indigenous residents, which include 14 public washing stations (figure 3), bathrooms, and public toilets in *kampongs* with proper hygiene and drainage standards (Departement van Binnenlandsch Bestuur, 1929, p. 97; Tillema, 1915). *Gemeente Bandung* also provides 72 public drinking water taps and 333 hydrants to anticipate *kampong* fires (Gemeente Bandoeng, 1919, p. 30).

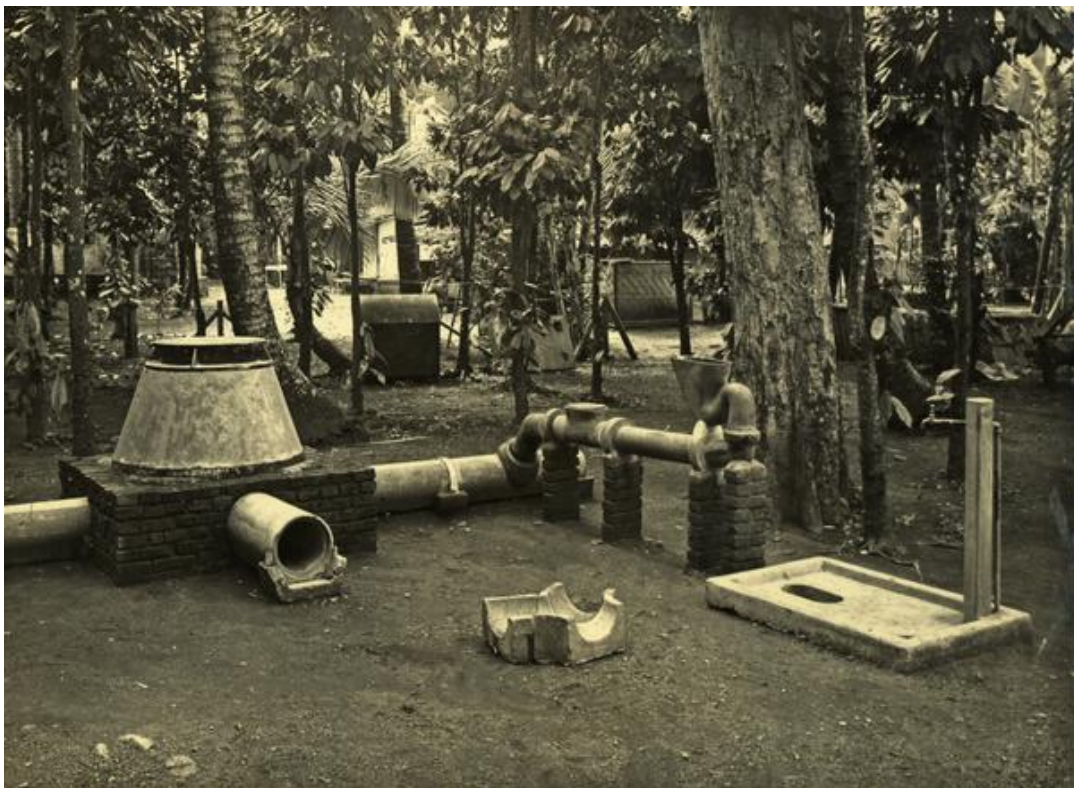


Figure 3. KITLV 157053, Public washing station in *kampong* (KITLV, 1929).

The construction of pipelines continues to be carried out in line with the expansion of residential areas in the north of Bandung. According to a 1916 *Gemeente* report, the main water pipeline network was 80 km (Gemeente Bandoeng, 1919, p. 30). By 1918, pipelines had been connected to 2081 locations, including settlements (Gemeente Bandoeng, 1919, p. 30). Bandung Public Works Departement began to explore the sources of springs in Cibadak (figure 4) and Cikendi springs, including water reservoirs in the two springs in 1921. Cikendi has a water flow of 240 liters/minute, and Cibadak has a water flow of 2,340 liters/minute (Gemeente Bandoeng, 1924). Clean water infrastructure was added by the construction of 3 reservoir buildings in Lembang Road, Cidadap, and Sumatra Street (figure 5) (Bandoeng, 1929).



Figure 4. KITLV 11931, Opening of Cibadak Reservoir (KITLV, 1921).

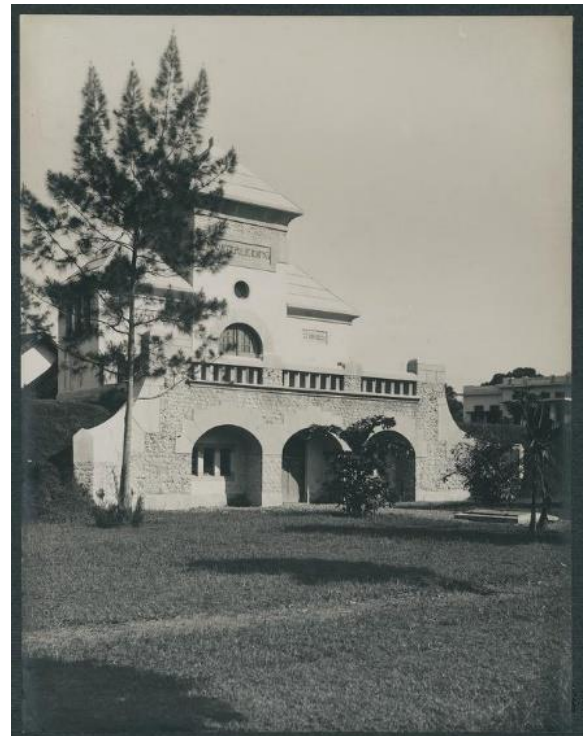


Figure 5. KITLV 11898, Reservoir at Sumatera Street (KITLV, 1920b).

Although the pipeline network continues to expand, the water supply depends only on seven wells and two main springs of the city (Walland, 1922, p. 961). This condition can cause a clean water crisis during the dry season. Moreover, water consumption also increased in line with the rapid population growth from 1915 to 1920. Furthermore, water flow in some of the artesian wells began to decrease. To prepare for these circumstances, *Gemeente* Bandung established a commission in 1921 called the *Waterleiding Commissie* to investigate new water sources. The commission comprised hydrologists and civil engineers, including Ir. C. A. De Jongh, from the Mining Department (*Lands Mijndiensten*) (Walland, 1922, p. 961). According to the commission's calculations, Bandung needs to increase the water flow from

120 liters/second to 270 liters/second. This calculation was based on the projected population until 1940, estimated to reach 194,000 people with a daily water requirement of 23,400 m³ (Walland, 1922, p. 962). Such a large daily water requirement can be achieved if the water flow in Bandung reaches 270 liters/second. To achieve this goal, *Waterleiding Commissie* has identified points of springs to explore in North Bandung: from Dago to around Tangkuban Parahu Mountain (Van Bemmelen, 1934; Gemeente Bandoeng, 1924). The new water source that has been successfully discovered and qualified based on the *Waterleiding Commissie* assessment is listed in Table 1.

Table 1. Recommended springs by *Waterleiding Commissie* (Gemeente Bandoeng, 1924, p. 3).

No	spring	Estimated minimal water flow	Minimal water flow measured in 1923
1	Cigerohong	10 liter/second	-
2	Citelaga I	13 liter/second	1,2 liter/second
3	Cicariuk	30 liter/second	22 liter/second
4	Cisalada I	25 liter/second	12 liter/second
5	Cisalada II		7 liter/second
6	Cipancak	15 liter/second	--
7	Cipulus	--	14,5 liter/second

In addition to the seven main springs recommended, the *Waterleiding Commissie* also successfully identified and researched 18 alternative springs that could be explored. *Waterleiding Commissie* divides all spring points into four complexes: complex I on Lembang Road, complex II in Sukawana, complex III in Ciater, and Complex IV in the hills of northern Bandung (Gemeente Bandoeng, 1924, p. 6). Based on these recommendations, *Gemeente* Public Works Departement was only able to follow up with the exploration of Cisalada I and Cisalada II, Cicariuk, Ciliang, and Ciwangun spring, including the construction of pipelines connecting the five springs in 1925 and 1926 (Bandoeng, 1929; Thijsse, 1935, p. 43). The last spring explored was Cigentur Spring in 1934. Referring to the *Bandoeng en de Hygiene* brochure compiled by *Gemeente Bandoeng* (1929), the water pipelines successfully built until 1929 had a total length of 130 km, with 9 km of pipelines connected to reservoirs.

Until 1934, clean water services in Bandung have several important infrastructures: artesian wells, springs, reservoirs, manifold pipelines, Mannesmann pipes, and public facilities for clean water providers such as hydrants, drinking water

taps, toilets, bathrooms, and public washing. Public toilets, bathrooms, and washes are usually built in *kampongs* (Kampong Toestanden, 1925).

Table 2. Clean Water Service Infrastructure in Bandung in the 1930s*.

Artesian Well	Spring	Reservoir	public facilities	Pipelines
Dago	Cikendi	Cikendi	70 public toilet	The 139 km long Manifold and Mannesmann pipelines
Oud Merdika,	Cibadak	Cibadak	70 public bathroom	
Pasirkaliki	Cisalada I	Cisalada I	70 public laundering	
Citepus	Cisalada II	Cisalada II	72 drinking water tap	
Cicendo	Cicariuk	Cicariuk	333 hydrant	
Balubur	Ciliang	Ciliang		
Post Road	Ciwangun	Ciwangaun		
	Cigentur	Lembang Road		
		Sumatera Street		

*Source: Author's reconstruction based on data in *Waterleidingrapport* (Gemeente Bandoeng, 1924), brochure *Bandoeng en de Hygiene* (Bandoeng, 1929), and articles written by Thijssse (1935) about waterways and decarbonization installations in Bandung.

Distribution and technology.

In the early 20th Century, Bandung's piped water services were made possible due to the appropriate application of science and technology by the Bandung Public Works Department. The department utilized hydrological, geological, hydraulic engineering, and bacteriology to run the water services. This scientific approach was applied to the natural potential of Bandung's mountainous landscape, rich in water resources. To supply water to urban areas with flat ground surfaces, the Public Works Department utilized water from deep underground sources, such as artesian wells (Bergmans, 1909; Lith, Spaan, & Fokkens, 1900a). Water from artesian wells avoids several harmful pathogens, but artesian water sometimes still contains manganese compounds (non-pathogenic) (Thijssse, 1935). Water from artesian wells in the middle of the city was collected in reservoirs and then flowed to settlements using manifold pipelines

(Gemeente Bandoeng, 1924). To distribute water to areas with slightly higher surfaces, pump technology was utilized through manifold pipes. This simple system was effective when the population of Bandung was few between 1910 and 1915. As the population grew, the artesian well became insufficient to meet the increasing demand. Engineers and geologists then began to search for alternative water sources from the highlands of Bandung.

Water sources in the form of springs in the highlands of Bandung were accommodated in reservoirs. It is on these reservoirs that engineers apply limestone filtration and aeration methods to produce cleaner water; avoid carbonic, carbonate, and bicarbonate acids (Thijssse, 1935). The limestone filtration method was a process of purifying water by using limestone as a filtering medium. Limestone aids in reducing the levels of heavy metals and other chemical elements, increase the water's pH level, and make it cleaner and safe for consumption. The aeration method was a way of water treatment that utilized additional oxygen to help remove contaminants and harmful materials from the water. The limestone filtration method was applied in Cikendi, Cibadak, Ciwangun, and Ciliang reservoirs. Meanwhile, the aeration method was applied in the Cisalada I, Cisalada II, and Cicariuk reservoirs (Thijssse, 1935, p. 44). Water purification methods are applied to reservoirs, resulting in a combination of complex water treatment technology with magnificent building architecture (figure 4 and 5). According to Thijssse (1935, p. 45), applying limestone filtration and aeration technology to the reservoir costs 50,000 guilders with an annual maintenance cost of 3000 guilders.

The water distribution process in Bandung (Figure 6) benefits from the city's land contour, which slopes southward. The springs on the plateau north of Bandung can easily flow south by following the law of gravity. The water flow from the north was then distributed to the city using the Mannesmann pipe (Gemeente Bandoeng, 1924). To distribute water evenly throughout the city, the Public Works Department applies hydraulics techniques. Based on the principle of hydraulics, Bandung was divided into three zones: high zone, flat zone, and low zone. Each zone has a separate reservoir on a more elevated surface, making water distribution easier.

Water was channeled from each reservoir in the three zones to settlements, schools, hotels, factories, markets, and companies. To facilitate water flow control from each reservoir, the Public Works Department began using centralized electronic water flow measuring instruments in 1931 (Rietschoten, 1932). Such water current gauges are connected to the entire reservoir by electric power. With these gauges, the Bandung Water Company can easily monitor water flow per day (Rietschoten, 1932).

Clean water management and regulation.

The institution directly responsible for the clean water supply in Bandung was the Bandung Public Works Department (*Gemeente Werken*). In 1914, Heetjans was appointed Director of the Bandung Public Works Department and co-headed the

construction process of the Bandung clean water pipeline (Tillema, 1915, p. 103). During Heetjans' reign (1914-1928), much of the city's infrastructure was built, including clean water service infrastructure. In 1922, The Public Works Department established a special division responsible for providing clean water, namely the Public Works and Water Supply Division (*Publieke Werken en Waterleiding*). G. van Galen Last initially headed the division, then in 1924, it was replaced by Poldervaart (Algemeen Indisch Dagblad, 1931b).

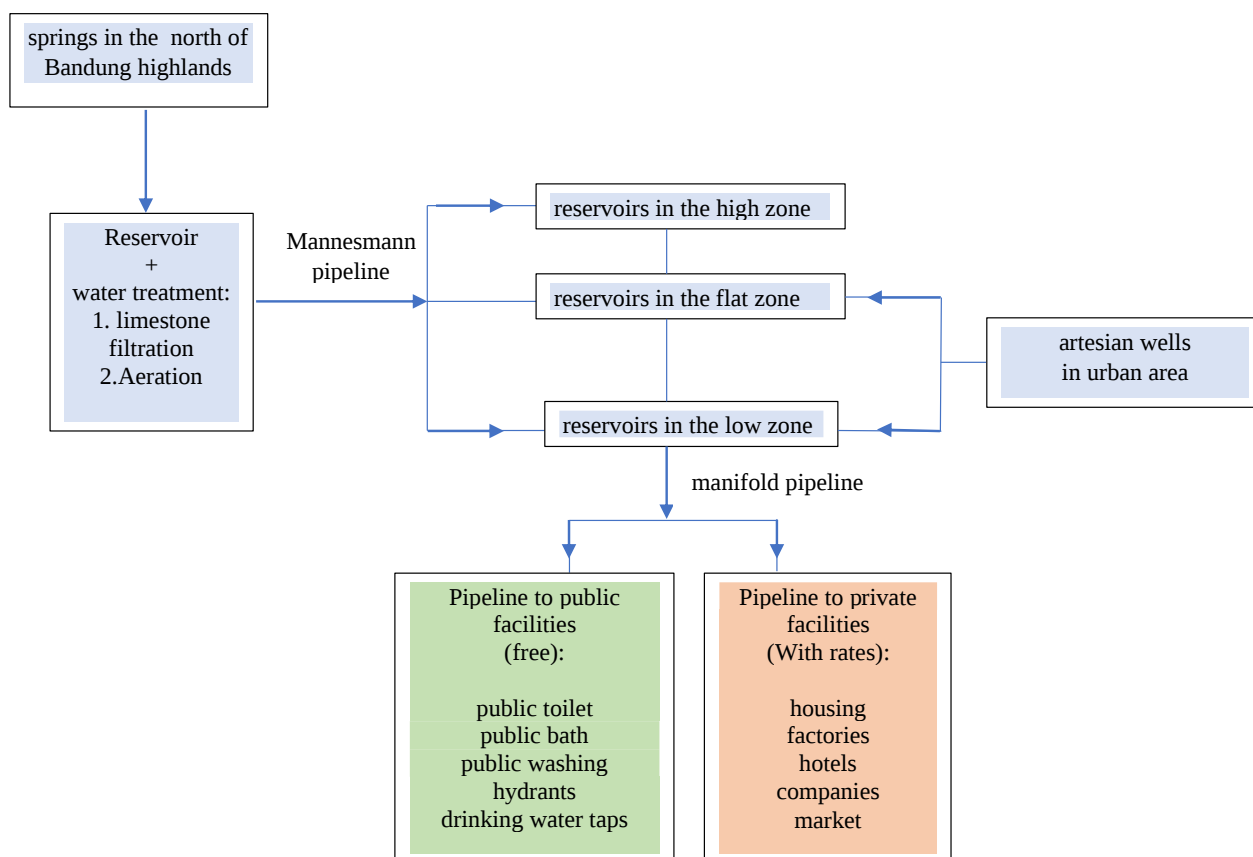


Figure 6. Water distribution scheme in Bandung in the 1930s. Source: reconstruction based on *Bandoeng en de Hygiene* (Bandoeng, 1929) and Thijsse's article on waterways and decarbonization installations in Bandung (1935).

The Bandung Public Works Department provides clean water. It is also assisted by other institutions such as the Mining Department (*Mijnwezen*), the Pasteur Institute, and the Bandung Technical High School (*Technische Hoogeschool*). Engineers from the Mining Department, such as Ir. C. A. de Jongh, worked in the early stages of geological surveys to determine water sources that could be explored (Gemeente Bandoeng, 1924). Public Works Department then follows up by excavating and building infrastructure that supports water availability. The infrastructure includes wells, reservoirs, water treatment units, and water distribution pipelines. Meanwhile, bacteria experts from the Pasteur Institute were tasked with checking bacterial levels in water sources found in Bandung. Once a water source was available, bacteriologists

checked the water once a month to make sure water was safe for consumption (Bandoeng, 1929, p. 31).

For research and water purification efforts, The Bandung Public Works Department also involved researchers from the Water Purification Laboratory (*Laboratorium van Waterzuivering*) in Manggarai, Batavia (Thijsse, 1934). Engineers who work at *Technische Hoogeschool* Bandung, such as Ir. Jac. P. Thijsse Jr. and Dr. C. P. 's Mom conduct research and development related to the water supply. C. P.'s Mom researched the relationship between drinking water, soil pollution, and intestinal diseases (gastroenteritis) (Mom, 1931). Thijsse Jr. conducts development and research on types of water purification technology suitable for water sources in North Bandung (Thijsse, 1935).

The Bandung Water Company (*Gemeentelijk Waterleiding Bedrijf*) was responsible for maintaining clean water infrastructure, distributing water to residents, collecting clean water customer dues, and managing the budget (*Algemeen Indisch Dagblad*, 1931c). The division of roles and functions of these various institutions was only able to run well in the second decade of the twentieth Century when *Gemeente* Bandung was more established in terms of finance and managerial (*Algemeen Indisch Dagblad*, 1931c; Bandoeng, 1929).

Well-planned clean water management based on the legal regulation was only formed on April 28, 1911, through the Water Ordinance for Bandung (*Gemeente Bandoeng*, 1921, p. 154). The regulation, continuously updated until 1916, explained that water supplies obtained from public facilities could be used freely and free of charge. Meanwhile, those who want water pipe services directly to households, shops, offices, and companies must register with the Bandung Public Works and Water Supply Division. In the Water Ordinance, there are detailed rules on water usage tariffs. Customers were charged a rate based on the building's monthly rental figures. For example, for a building whose monthly rental value was between 5–10 guilders, a fee of 0.5 guilders was charged per use of 1 m³ of water. The higher the rental value of the building, the higher the price of water for every 1 m³ (*Gemeente Bandoeng*, 1921).

This condition illustrates that the Bandung municipality government has been able to capitalize on the water resources they manage. Bandung, in the early 20th Century, saw the establishment of many companies, hotels, and government employee settlements that required a lot of water supply. Therefore, the practice of water management became profitable. In 1930, Bandung Water Company profited 650,000 guilders from 12,250 customers (*Algemeen Indisch Dagblad*, 1931c). Bandung Water Company's profits continued from 1916 to 1930 (*Algemeen Indisch Dagblad*, 1931c). In 1931, Bandung Water Company invested 1,850,000 guilders in realizing a water supply that could cover 50% of Bandung's population (*Algemeen Indisch Dagblad*, 1931c).

The regulation of clean water and the capitalization of clean water sources shows the segmentation of water access in Bandung in the early 20th Century. The provision of water pipelines to houses at certain costs and administrative rules may only be

fulfilled by the upper middle class, such as European employees, business people, and government employees. Clean water services support water-based companies like mineral water factories, swimming pools, and hotels with hot water facilities in Bandung by providing a large water supply (Algemeen Indisch Dagblad, 1931a).

For economically disadvantaged groups, such as indigenous residents in a *kampung*, access to clean water was only possible through shared public facilities, including water taps, toilets, washing areas, and bathrooms (Bandoeng, 1929; Kampong Toestanden, 1925). To get clean water, they must walk to available public facilities. This practice was common in the Dutch East Indies. Indigenous people were accustomed to bathing and washing clothes in public areas such as rivers and public washing (Taylor, 2013). This condition is reflected in the folklore of *Roesdi jeung Misnem*. In the folklore, it is told about a boy named Ramlan and Rusdi who had to walk from *kampung* to the town square to take an afternoon bath at the location of an artesian well (Deenik & Djajadiredja, 1930, p. 96). This condition is in contrast to Europeans who can access water in their own houses, behind closed walls, and privately (Taylor, 2013). Providing clean water pipes directly to houses was a privilege for economically established groups.

Conclusions.

This study reveals that in the 19th Century, the people of Bandung, West Java, Dutch East Indies (Indonesia) relied on natural water sources without state intervention. The Indigenous population uses water from rivers and springs, utilizes simple technologies such as *panchuran*. They harmonize local knowledge with nature and beliefs. At the same time, Europeans relied on dug wells. The Dutch East Indies government became involved in clean water exploration begin 1898 through the Department of Waterworks, which initiated the excavation of artesian wells.

As Bandung grew more crowded in the early 20th century and disease outbreaks like cholera became prevalent, the Bandung Municipality Government recognized the need to control and manage clean water sources. Between 1911 and the 1930s, they embarked on infrastructure development based on science and technology to enable well-planned and profitable clean water management. At this point, technology becomes a medium that helps the Bandung Municipality Government to control water sources. The Bandung Municipality Government explored clean water sources in the urban areas and the mountainous regions north of Bandung. However, clean water services were only partially free for residents. Wealthier European residents used paid, directly accessible piped water services from their households. In contrast, indigenous residents in *kampongs* had to rely on public facilities far from their homes.

This study suggests further investigation to assess the environmental impact of water source exploration during the colonial period. In particular, additional research should focus on environmental and postcolonial history to understand the influence of colonial-era exploitation on current water availability and accessibility in urban areas.

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Conflicts of interest.

The authors declare no conflict of interest.

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Від панчуран до водопостачання: рішення щодо чистої води в колоніальному Бандунгу, Західній Яві, Голландській Східній Індії (1898–1934)

***Анотація.** Це дослідження розглядає управління чистою водою в Бандунгу, Західній Яві, Нідерландській Східній Індії (Індонезія) з кінця 19-го до початку 20-го століття. Це дослідження зосереджено на тому, як людське співтовариство змінило фізичну одиницю води, включаючи технологію, навички управління та соціальні та екологічні пріоритети. Для вивчення теми були використані історичні методи, включаючи евристику, верифікацію, інтерпретацію та історіографію. Більшість даних у цьому дослідженні були зібрані з первинних джерел у вигляді архівів та офіційних документів Департаменту громадських робіт та муніципального уряду міста Бандунг, опублікованих з кінця 19-го століття та до першої половини 20-го століття. Результати показали, що корінні жителі Бандунгу, сунданці, керували джерелами та річками на основі місцевих знань, гармонізуючи просту технологію з природою та віруваннями. Вони використовували панчуран, канал із плетених палиць бамбука, для відведення води з джерел. У той час, як європейці спочатку користувалися копанням криниць для повсякденних потреб у воді наприкінці 19-го століття. Однак у зв'язку зі збільшенням епідемій та швидким зростанням населення на*

початку 20-го століття, з'явилися стурбованість щодо епідемій та потреби в більш обдуманому та професійному управлінні водопостачанням, підкріпленому науковою базою та технологічною інфраструктурою. Уряд муніципалітету Бандунгу залучив інженерів та вчених для дослідження нових джерел води та будівництва інфраструктури для чистої води. До 1930-х років вони змогли побудувати артезіанські свердловини, мережі водопроводів, резервуари, системи фільтрації та громадські об'єкти для чистої води. Уряд муніципалітету Бандунгу розширив діапазон джерел чистої води від міських до гірських районів на північ від Бандунгу. Муніципалітет визнавав, що ресурси чистої води потребують дослідження та раціонального використання. В Бандунгу були доступні два сервіси забезпечення чистою водою: послуги трубопровідного водопостачання, що доставляли воду безпосередньо до будинків, та доступні громадські об'єкти. Корінні жителі Кампонгу використовували громадські об'єкти, тоді як європейці користувалися платними послугами трубопровідного водопостачання.

Ключові слова: чиста вода; водні захворювання; інфраструктура; техніка; екологічна історія; Бандунг

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Analysis of the history of creation and improvement of personal protective equipment: from bronze armor to modern bulletproof vests

Abstract. *In this article, using real historical examples, the authors tried to trace the evolution of personal protective equipment. This has made it possible to perform a comparative historical analysis of the development of scientific research and industrial technologies, which made it possible to manufacture specific personal protective equipment in a certain historical period. Also in this review article, the authors have analyzed the stages of modern technologies that are currently used in the manufacture of various types of bulletproof vest. And given that the overwhelming majority of authors of publications devoted to the history of the creation of bulletproof vests write that: the bulletproof vest does not have a specific inventor, in this review article the authors also talk about specific, undeservedly forgotten now, the creators of the world's first officially patented prototypes of bulletproof vests for the police and VIP-persons, at the beginning of the 20th century, who stood at the origins of the bulletproof vest industry. With the development of the industrial revolution and technological progress, new materials and production technologies have appeared, allowing the creation of more effective bulletproof vest. Bulletproof vest has become lighter and more effective over time, thanks to the use of new materials such as Kevlar, aramid fibers and ceramics. Thus, the history of the development of bulletproof vest includes the contribution of many scientists, engineers and inventors who have contributed to the improvement of protective armor over the years. In the article, the authors show that modern realities put forward new requirements for quality, weight and functional characteristics for design engineers and manufacturers of bulletproof vest. The authors of the article analyze the main directions in which research work is currently underway*



to improve bulletproof vests. The authors of the article show that in different countries of the world there are different standards and classifications for bulletproof vest. Each standard usually has its own classification, which determines the level of protection of bulletproof vest against specific types of threats, such as bullets, shrapnel or stab wounds. Therefore, the task of developing a single standard for modern bulletproof vest is important.

Keywords: body armor; bulletproof; Casimir Zeglen; Jan Szczepanik; Stephanie Louise Kwolek; kevlar

Introduction.

The bulletproof vest (or protective vest), as such, cannot be attributed to one particular inventor. Various forms of armor and protective materials have been used over the centuries to protect against various types of attacks, including attacks using firearms. The bulletproof vest familiar to our contemporaries was developed at the beginning of the 20th century. Several scientists and engineers have contributed to the development of protective vests, and one inventor cannot be unequivocally named.

However, ideas for the creation of protective vests arose long before that time. The ancient Romans used prototype bulletproof vest made of metal plates known as "lorica segmentata" (Fig. 1) during their military campaigns (Bishop, 2002; Argüín, 2006; Tonc, Dizdar, & Vulić, 2022).

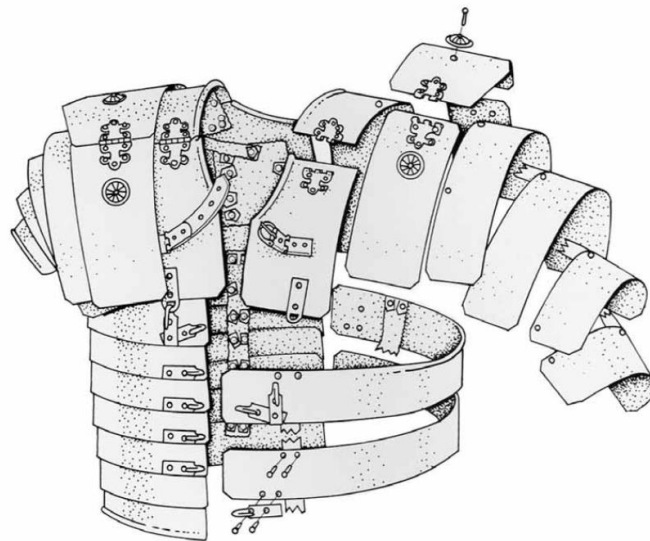


Figure 1. Lorica segmentata tipo «Corbridge». (Argüín, 2006).

Throughout history, there have been many other attempts to develop bulletproof vest and other types of protective equipment. One of the earliest examples of bulletproof vest is mail, which consisted of metal rings tied together. Mail was widely used by various armies in Medieval Europe and other parts of the world.

In the 16th and 17th centuries, the first experiments appeared with metal plates worn on the body to protect against bullets and saber blows. However, these early prototype bulletproof vest were bulky and limited in their effectiveness. In more

modern times, the development of bulletproof vest is associated with the advent of firearms.

With the development of the industrial revolution and technological progress, new materials and production techniques have appeared, allowing the creation of more effective bulletproof vest. Bulletproof vest has become lighter and more effective over time, thanks to the use of new materials such as kevlar, aramid fibers and ceramics (Kathiervelu, 2003; Godara, Yadav, Goswami, & Rana, 2021; Mishra, Madhad, & Vasava, 2021).

Thus, the history of the development of bulletproof vest includes the contribution of many scientists, engineers and inventors who have contributed to the improvement of protective armor over the years.

The main purpose of writing this article is to trace the evolution of personal protective equipment using real historical examples, and to give a comparative historical analysis of the development of scientific research on innovative materials and industrial technologies that made it possible to manufacture personal protective equipment in one or another specific historical period.

Also, the aim of this article is to analyze modern materials and technologies that are currently used in the manufacture of various types of bulletproof vest.

The overwhelming majority of authors of publications devoted to the history of the creation of bulletproof vests write that: the bulletproof vest does not have a specific inventor. This is not entirely true. The authors of this article consider it necessary to analyze the available information and tell about the specific, undeservedly forgotten now, the creators of the world's first prototypes of bulletproof vests for the police and VIPs. Since at the beginning of the 20th century it was they who stood at the origins of the bulletproof vest industry, and their technological developments are still used by design engineers in many countries of the world.

Chronology of the creation of personal protective equipment.

Since ancient times, man has been trying to protect himself during battles by putting on various protective ammunition (Charles, 2012; Nayak, et al., 2018; Manning, 2021). In addition to protective functions, it gives warriors an undeniable advantage over the enemy, if he does not have such protection.

The ancient Greek warriors and legionnaires of the Roman Empire owe their military success to the armor of that time, which reliably protected them: helmets, breastplates, shoulder pads and knee pads, which were made mainly of bronze (Aldrete, Bartell, & Aldrete, 2013).

In the Middle Ages, practically no one could resist the heavy knightly cavalry, because the knights were practically invulnerable thanks to steel armor on top, and chain mail worn under them on the body, made of tightly woven metal circles.

It was at this time in Europe and Japan that a certain prototype of a modern bulletproof vest appeared, which went down in history under the name "brigandine". Plates or various forms of some kind of metal were sewn onto a rough canvas fabric.

Such "brigantides" were worn by warriors under armor, or by civilians under outerwear.

As shown in fig. 2, it exhibits the bascinet of the earliest years of the fifteenth century, a brigandine of few plates, the typical defenses of arms and legs with small "shells" at elbow and knee, the small and separate shoulder defense, and the short-cuffed gauntlets, precisely as one sees them represented in tomb figures of about 1400 (Dean, 1925).



Figure 2. The bascinet of the earliest years of the fifteenth century, a brigandine of few plates, the typical defenses of arms and legs with small "shells" at elbow and knee, the small and separate shoulder defense, and the short-cuffed gauntlets (Dean, 1925).

The development of firearms has made its own adjustments to the evolution of body protection elements. It no longer made any sense to put on heavy knightly armor, because they easily made their way not only with artillery grapeshot, but even with simple bullets fired from muskets, arquebuses and pistols.

Only metal cuirasses remained in the protective equipment of cavalymen in the 17th–18th centuries. Depending on the country where they were used, cuirasses were either only breastplates, or consisted of two parts that protected their owner from two sides: from the side of the chest, and from the back.

As an illustrative example, here we can recall the legendary Polish winged hussars of the Commonwealth, who dressed in segmented metal cuirasses before the battle, and fluttered behind them, fastened to the saddle, huge wooden wings decorated with eagle and falcon feathers, called upon during a swift attack, fluttering in the wind, to intimidate the enemy (Fig. 3).



Figure 3. ArtStation – Battle of Kirchholm. Polish Winged Hussars (Kozik, 2011).

Cuirassier cavalry regiments existed in the armies of European states until the beginning of the 20th century and took an active part in the World War I (Philips, 2011).

Various types of cuirasses and steel breastplates, although not widely used, were used as experimental samples to supplement the ammunition of soldiers during the World War I (Fig. 4) and World War II.

Until the beginning of the 20th century, inventors and design engineers who developed wearable personal protective equipment constantly faced a dilemma that the materials and scientific and industrial technologies of those times that they had at hand did not allow them to solve as rationally as possible. On the one hand: wearable personal protective equipment had to reliably protect its owner from knives and firearms. Therefore, various metals were mainly used for their manufacture. On the other hand, inventors and design engineers were aware that the weight of wearable personal protective equipment should be within reasonable limits and, if possible, not restrict the movements of a person when wearing them.



Figure 4. Result of Ordnance Department body armor test at Fort de la Peigney, Langres, France. Exhibit of body armor, heavy weight, showing effect of pistol, rifle and machine gun fire. (Army Ordnance Department, 1918).

Here it is impossible not to recall the history of the famous Australian gang of (Utley, 2015). At the end of the 1870s, she directed horror on the police of the green continent, robbing banks and killing constables. They could not neutralize the gang for several years, although the Australian police attracted significant forces for this.

During skirmishes with bandits, the police naturally shot to kill, mainly in the chest and heart area. When the gang was finally caught, it turned out that the inventive "gentlemen of fortune" wore homemade steel armor that bullets could not penetrate.

The famous English writer Arthur Conan Doyle was told this adventurous story by one of his acquaintances. The author of the detective Notes on Sherlock Holmes, who was in close contact at that time with representatives of the police and the Ministry of Defense of Foggy Albion, advised British infantry soldiers to be dressed in such armor (Lycett, 2011). But in the military department, such an idea was very skeptical, and tactfully rejected it. Because the home-made steel breastplates and other armor of the Australian "gentlemen of fortune", although they did not make their way through bullets from rifles and revolvers, even almost point-blank, because they were almost 7 millimeters thick, but at the same time they had simply unbearable weight. For example, the "armor" of gang leader Ned Kelly (Fig. 5) weighed 47 kilograms (Utley, 2015).

In addition to the total weight of the personal protective equipment and the mobility of a person when wearing it, inventors and design engineers had to take into account the third important technical aspect when creating them. This is the so-called: armored action from a direct hit by a bullet or a fragment of an artillery shell. A blow of enormous power could lead to a fracture of the ribs or even to the rupture of internal organs.



Figure 5. Ned Kelly armour, located at the State Library of Victoria, Melbourne, Australia (Findlay, 2020).

It is no coincidence that during the World War II, soldiers of the Red Army of the Soviet Union always wore thick padded jackets under steel breastplates (Fig. 6), which, in the event of a bullet or shrapnel hit, significantly softened the force of impact (Melkin, 2019).



Figure 6. Soldiers of the Red Army of the Soviet Union in steel bibs during street fighting in Stalingrad in 1943 (Budanovic, 2017).

Creators of the first officially patented bulletproof vests.

As we noted at the beginning of this article, the vast majority of authors of publications devoted to the history of the creation of bulletproof vests write that: the bulletproof vest does not have a specific creator. This is not entirely true. The first analogues of modern bulletproof vests were created and officially patented in the United States of America by Kazimir Zeglen, and in Europe by Jan Szczepanik (Collins, 2005; Risteski & Srebrenkoska, 2020). By coincidence, these two inventors of the first bulletproof vests have Ukrainian roots.

Because Jan Szczepanik was born in 1872 in the village of Rudniki on the outskirts of the town of Mostyska (in modern Ukraine, this is the regional center of the Lviv region) (Trzaska, 2011).

And his counterpart Kazimir Zeglen in 1869 in Ternopil (the regional center of modern Ukraine) (Łotysz, 2014).

We can say that they are both of them are now undeservedly forgotten, although at the beginning of the 20th century it was they who stood at the origins of the industry for the creation of bulletproof vest for the police and VIPs, and their technological developments are still used by design engineers in many countries of the world.

Jan Szczepanik.

It was he who created and patented the first bulletproof vest in Europe based on a silk multilayer fabric, stitched for reinforcement with the finest metal threads. To do this, he improved the loom, on which it was possible to produce such a fabric on an industrial scale. On Zeglen's commission he developed an industrial method of producing a bulletproof fabric, which not only made it possible to lower its price, but also improved the parameters of its endurance (Łotysz, 2009).

Figure 7 shows a world's first during tests of bulletproof armor. A shot at Szczepanik bulletproof armor in the courtyard of the Patronage House in Vienna in

1901. Director of the Patronage House Borzhikovsky shoots a clerk from a distance of 3 steps with a 7mm revolver, who is wearing bulletproof armor.



Figure 7. A shot at the bulletproof armor of the Shchepanik system (Głos Narodu, 1901, December 7, p. 13).

Bulletproof fabric woven on the looms of Jan Szczepanik in 1906 during the assassination attempt on Alfonso XIII King of Spain actually saved the life of the monarch (Trzaska, 2011). A powerful bomb was thrown under the king's carriage, the explosion of which killed or injured more than 100 people who were nearby at that moment. The king and all who were in the carriage were not injured, only because from the inside it was sheathed with bulletproof multi-layered fabric for safety reasons. For which Jan Szczepanik was awarded the honorary title of Knight of the Order of Isabella the Catholic. Bulletproof vests created by Jan Szczepanik at the beginning of the 20th century were worn by many European politicians and government officials of the highest rank.

Casimir Zeglen.

He was a Polish Catholic priest who emigrated to America in 1890 (Łotysz, 2014). In 1893, the mayor of Chicago (Collins, 2005), whom Casimir Zeglen respected greatly, was shot dead, and was shocked by his death. This was the reason for the beginning of his active experiments on the creation of bulletproof vest on a fabric basis (Łotysz, 2014).

One day, an article by the famous doctor and medical examiner from Arizona, George Emery Goodfellow, accidentally came across his eyes, in which the case was described in detail when, while examining the corpse, he discovered that one of the revolver bullets that literally riddled the body of the unfortunate man was stuck in the

breast pocket of his jacket in a tightly folded silk handkerchief (Risteski & Srebrenkoska, 2020). Casimir Zeglen noted this interesting detail for himself, and discarding all other materials with which he had worked before, he finally chose silk (Łotysz, 2014).

As a result, it was he who invented an innovative method of weaving silk for a fabric capable of protecting a person from firearms.

The innovative multi-layered silk fabric was woven in factories in Austria and Germany, because only they at that historical moment could guarantee the highest quality of products, which was so necessary for Casimir Zeglen.

Bulletproof multi-layered silk vests, when hit, perfectly stretched at the point of impact and extinguished the energy of lead bullets fired from revolvers almost at close range, as well as steel bullets fired from afar.

In 1897 Casimir Zeglen officially patented his bulletproof vests (Łotysz, 2009).

To establish their industrial production, he was forced to look for business partners in Europe. In the same spring of 1897, Kazimir Zeglen met Jan Szczepanik, who invited him to start the production of bulletproof vests on an industrial scale on the automated looms of his company. They signed a commercial agreement and began to cooperate, but later, due to financial disagreements, their commercial relationship was interrupted. And each went on his own way.

New materials and new technologies.

The USA.

In the 1930s, in the research laboratories of the largest American chemical corporation DuPont, such innovative materials for those times as nylon, neoprene and teflon were synthesized (Singha, Maity, Pandit, & Mondal, 2022).

It was from multilayer ballistic nylon that the United States created the world's first military bulletproof vest M-1951, which was put into mass production and was used by American soldiers during the fighting in Indochina during the Korean War (1950–1953) (Howard, 2020; Melkin, 2019). Statistical data showed that the personnel received the most injuries from fragments of mines, hand grenades and artillery shells Melkin, V. (2019). Up to seventy percent of shrapnel wounds were in the upper torso.

Therefore, the creators of the M-1951 army bulletproof vest were tasked with protecting the marines primarily from fragments (Howard, 2020). Although the developers made the M-1951 universal by providing pockets in it, where aluminum or steel plates could be inserted to cover the chest and heart area. Without metal plates, the M-1951 army bulletproof vest weighed only 3.51 kg, so it did not hamper the movements of the Marines during the battle, even allowing them to move on the ground in a plastun way if necessary.

In May 1943 the Dow Chemical Company laminated a fibrous glass fabric which immediately proved very promising (Pike, 2011). The initial product consisted of layers of glass filaments of Fiberglas bonded together with an ethyl cellulose resin under high pressure. Some of the individuals working with Col. (later Brig. Gen.)

Georges F. Doriot, then director of the Military Planning Division, Office of the Quartermaster General, decided that the project should be known as the "Doron Project" in his honor. Therefore, the glass fiber laminate manufactured by the Dow Chemical Company became known as and continued to be called doron. The production of the M12 vest was slated to continue to a certain degree after August 1945. The M12 vest was made of thick aluminum plates and had layers of nylon cloth. It weighed 12 pounds and 3 ounces and provided an area protection of 3.45 square feet. The design had been modified to provide greater protection for the anterior portion of the thorax both by increasing the width of the main frontpiece and also by increasing the size of the anterior flap over the heart and great vessels. It was not until the Korean War that it was utilized in the field. With the rebirth of body armor during the Korean War, the M12 vest was used initially by American troops in conjunction with the newer all-nylon-type vest. Following the completion of the initial surveys and standardization of the final end item, all US frontline troops were equipped with the newer all-nylon or doron vests, and the M12 vests were used by Republic of Korea troops.

Figure 8 shows a soldier displays a piece of shrapnel that lodged in his armored vest during frontline action in Korea on March 30, 1952 (Morrell, 2014). The impact knocked him to the ground, but the vest, reinforced with Doriot's "Doron," was credited with saving him from serious injury (source Associated Press).



Figure 8. A soldier displays a piece of shrapnel that lodged in his armored vest during frontline action in Korea on March 30, 1952 (Morrell, 2014).

During the Korean War, several more modifications of army bulletproof vests were released, in particular, the M-1952 (Prat, Rongieras, Sarron, Miras, & Voiglio, 2012). In their advanced anti-fragmentation equivalent of the M-1969 (which weighed 3.85 kg), most American soldiers went through the Vietnam War (1964–1973), because its wearing was mandatory for all personnel of any units participating in the hostilities in that country (Howard, 2020). Since 1967, the US Marines have been able to insert not only metal, but also fiberglass and ceramic plates into the breast pockets of their bulletproof vests to enhance protection.

Perhaps the biggest paradox in the field of scientific and technological progress in such a militaristic industrial branch as the creation of personal protective equipment is that a small and fragile woman, Stephanie Kwolek, made a significant contribution to its development. She ran a research laboratory at the American chemical corporation DuPont. Another oil crisis was approaching the world. So her lab was tasked with synthesizing a fiber that was light, flexible, versatile, yet strong enough to be used in the production of car tires. The result of the work of her research laboratory exceeded even the wildest expectations (Jethy, Paul, Das, Adesina, & Mustakim, 2022).

Kevlar was invented in 1964 (Melkin, 2019). In 1965, the technology for its industrial production was developed. And since the beginning of the 1970s, the production of various experimental products from Kevlar has begun, including Kevlar bulletproof vest.

It was the appearance of Kevlar, and also, along with it, high molecular weight polyethylene that opened the era of creating not only anti-fragmentation type PASGT, but also more reliable bulletproof vests, which in various modifications, constantly updated year after year, from the beginning of the 1980s, they began to massively enter service with the special services, the police and the US army (Marchenko, 2017).

PASGT (abbreviated from Personnel Armor System for Ground Troops), the system of individual armor protection of the ground forces) is an armor protection kit consisting of a bulletproof vest and an armored helmet (Roberts & Bullian, 1993).

PASGT was adopted by the US Army in 1980 (however, the start of delivery to the troops was scheduled for October 1981, after the completion of the production of the first batch of 130 thousand sets), and was officially in service until 2003 (in fact, a replacement for more perfect samples of personal armor protection occurred gradually, in 2004–2009) (Roberts & Bullian, 1993). Nevertheless, PASGT helmets and bulletproof vest are still in service with a number of US allied countries and are used by US private military and security companies. Although, according to American military doctrine, for a long time (until 1999), the marines were dressed in anti-fragmentation, and not in anti-bullet Kevlar bulletproof vest.

The USSR.

In the Soviet Union, which was the main military adversary of the United States, the All-Union Institute of Aviation Materials in 1954 developed the first Soviet anti-fragmentation and anti-bullet bulletproof vest with the abbreviation name 6B1 (Melkin,

2019). Small aluminum plates sewn into separate “pockets” were used as armor protection throughout the bulletproof vest. The overall cut was made of synthetic fabrics. Inside there was a soft cotton lining to reduce the armor effect of bullets and shrapnel. In 1957, an experimental batch of only 1,500 units entered service. But during the Cold War, the party and military leadership of the USSR relied on nuclear weapons of mass destruction. Rocket troops and long-range strategic aviation were considered priority. Therefore, large-scale production of the first Soviet bulletproof vest 6B1 was not started. Their mass production was planned to begin only in case of war.

In 1971, at the All-Union Research Institute of Steel, a specialized vest was created for KGB officers, police officers and prosecutors with the ZhZT-71 index (Melkin, 2019). At the very beginning of the war in Afghanistan (1978-1985), all 1500 of the first Soviet 6B1 bulletproof vests were transferred to units of a limited military contingent of Soviet troops. In the difficult mountainous terrain where the fighting took place, its operation immediately showed that it was too heavy (5.5–5.3 kg, depending on its size).

In 1979, the All-Russian Research Institute of Steel promptly developed the first Soviet Kevlar bulletproof vest 6B2, based on its own ZhZT-71 vest for law enforcement agencies (Marchenko, 2017).

The cut was made of TSVM-J fabric (analogous to American Kevlar). Armor protection was provided by with either 1.25 mm titanium plates inserted into the pockets (Cameron, 2017). The Soviet Kevlar bulletproof vest 6B2 weighed 4.2–4.8 kg (depending on its size) (Galeotti, 2023; Melkin, 2019). Bulletproof vest 6B2 became the main one for the entire Soviet-Afghan war for airborne and motorized rifle units. He provided reliable protection even with a direct hit on him by bullets fired from a pistol and shrapnel from mines and shells. But practically could not protect against rifles and machine guns.

Therefore, the military leadership of the USSR decided on the need to create an anti-bullet vest that can withstand the hit of automatic, rifle and machine-gun bullets with maximum all-round protection of the torso: from the chest and from the back.

The developed bulletproof vests with indexes 6B3TM (with either 6.5 mm titanium armor plates (Cameron, 2017) and a total weight of 12.2 kg), and 6B4 (with ceramic armor plates weighing 12 kg) held automatic bullets fired from a distance of 10–15 meters (Melkin, 2019). But because of their heavy weight, they could not be used by paratroopers and motorized riflemen for a long time. Since the fighters had to constantly move and move a lot during active combat.

An innovation in the design of the 6B3TM model was the appearance of cases/pockets for placing spare machine gun stores, hand grenades, and a portable radio in them (Melkin, 2019). But they did not abandon the idea of creating a powerful, reliable combined-arms bulletproof vest. On the basis of models 6B4 and 6B3TM in the mid-1980s, two bulletproof vests were developed and put into service in the USSR: 6B3-01 (Zh-85T) weighing 8.2 kg, and 6B4-01 (Zh-85K) weighing 7.6 kg. The reduction in the total weight of these two bulletproof vest was achieved by reducing

the thickness of the armor plates on the back. As a result, bulletproof vests were still bulletproof in front, and from the back they were anti-fragmentation.

Taking into account the experience of the Soviet-Afghan war in 1986, the All-Russian Research Institute of Steel developed a series of universal bulletproof vest 6B5 "Beehive" (Dragobetskii, Shapoval, & Zagoryanskii, 2015). They could provide a different level of protection, depending on what armor plates from what materials and what thickness they were equipped with.

The current stage of development of personal protective equipment.

In the 1990s and at the beginning of the 21st century, thanks to the latest technologies and the ultra-modern innovative materials obtained with their help, the production of bulletproof vests becomes massive.

They are beginning to be produced not only by state-owned enterprises of the military-industrial complex, but also by private firms. In order to avoid chaos in the production of personal protective equipment and streamline their production, in particular, bulletproof vests, every country in the world has a government organization that introduces certain standards, ensures compliance with them so that bulletproof vests meet these standards and bulletproof classifications (Nayak, et al., 2018; Kumar, Saxena, Sharma, Gangolu, & Prabhu, 2023).

In different countries of the world there are different standards and classifications for bulletproof vests. Some of the more common standards are listed below:

NIJ (National Institute of Justice) standards (USA). The NIJ is an agency under the US Department of Justice that develops standards for evaluating bulletproof vest. The most common classifications include NIJ Standard-0101.06 for ballistic bulletproof vest and NIJ Standard-0115.00 for stab protection. For example, NIJ 0101.06 standards define protection levels such as NIJ Level IIA, II, IIIA, III, and IV, where level IV provides the highest protection against high caliber bullets.

EN (European Norm) standards (Europe). European EN standards define the requirements for bulletproof vest in various European countries. For example, EN 1522 and EN 1063 define protection classes against firearms and fragments. Classifications include levels BR1, BR2, BR3, BR4, BR5, BR6 and BR7, where BR7 provides the highest level of protection.

VPAM (Vereinigung der Prüfstellen für angriffshemmende Materialien und Konstruktionen) standards (Germany). VPAM is a German organization that develops standards for bulletproof vests and anti-ballistic protection. They provide a classification for evaluating protection against firearms and other forms of attack.

ISO (International Organization for Standardization) standards: ISO develops international standards for various areas, including security technologies. Some ISO standards may be applicable to bulletproof vests and performance testing.

In Ukraine, the standards are developed and approved by the state enterprise "Ukrainian research and training center for problems of standardization, certification and quality". In Ukraine, the main legal act on which the protection classes of

bulletproof vests are determined by bullet resistance is the document DSTU 8782:2018 “For individual protection. Bulletproof vests. Classification. Global technical mind”.

These are just a few examples of the standards used in different countries to evaluate bulletproof vest. Each standard usually has its own classification, which determines the level of protection of bulletproof vest against specific types of threats, such as bullets, shrapnel or stab wounds.

A single world standard – a global classification – for bulletproof vests does not exist today, because in different countries of the world different ammunition and different methods are used when testing bulletproof vests.

The use of such ultra-modern synthetic materials as, for example, Kevlar, aramid, high-modulus polyethylene for the manufacture of a fabric base for bulletproof vests makes them easy to wear, reliable in a difficult combat situation and durable in storage (Kathiervelu, 2003; Arora & Ghosh, 2018; Buckner, 2021; Mishra, Madhad, & Vasava, 2021).

Most models of modern bulletproof vests for the police and the army, thanks to external covers/pockets for placing spare automatic magazines, hand grenades, and other ammunition in them, combined in their design the protective function of combat bulletproof vest with the function of a civilian unloading vest, which is used in everyday life by ordinary fishermen or utility workers/emergency services (Conroy & Park, 2022; Kukić, Janković, Dawes, Orr, & Koropanovski, 2023)..

Taking into account that in the manufacture of armor plates for modern bulletproof vest, various innovative synthetic polymers, metals and composite alloys, as well as ceramics are used, this allows manufacturers to complete their bulletproof vest with armor plates universally, depending on their areas of application (Godara, Yadav, Goswami, & Rana, 2021; Pathak, Patel, Gupta, & Bandaru, 2023; Rudi, Syahid, & Hayat, 2023).

Therefore, modern bulletproof vest can be:

- or universal, for example, light bulletproof vests of primary protection classes for security guards of various institutions and supermarkets.
- or, also as an example, heavy combat bulletproof vests of high protection classes for police special forces and special forces.

Considering modern realities, in the armies of the whole world and police special forces today, in addition to bulletproof vest, a helmet and other protective elements are used for additional comprehensive protection (Risteski & Srebrenkoska, 2020; Kukić, Janković, Dawes, Orr, & Koropanovski, 2023).

Therefore, in official documents of the defense departments of various countries today, such a definition as “modular bulletproof vest” is often used. That is, in addition to the bulletproof vest itself, a protective kit may include several other components (Fig. 9): a helmet, shoulder pads, knee pads, etc. (Marchenko, 2017).



Figure 9. US Marines in modern protective ammunition (Nemenov, 2007).

Modern realities put forward new quality requirements for design engineers and manufacturers of bulletproof vest, so today work is being carried out in three main areas.

Firstly, a modern bulletproof vest should have as large a protection area as possible, covering as many parts of the human body as possible, and at the same time remain relatively light and not restrict a person's movements during long-term movement (Marchenko, 2017; Risteski & Srebrenkoska, 2020; Conroy & Park, 2022).

Secondly, the armor plates in modern bulletproof vests must have the maximum degree of protection in terms of bullet resistance, and at the same time be thin in thickness and light in weight (Yadav, Naebe, Wang, & Kandasubramanian, 2016; Nayak, et al., 2018; Rudi, Syahid, & Hayat, 2023).

Thirdly, in order to reduce the armor effect in the event of a direct hit of a bullet or fragment in the armor plate, the fabric base from which the bulletproof vest is sewn must be multi-layered and must have one or more shock-absorbing linings from the inside (Cameron, 2017; Melkin, 2019).

Therefore, the history of the creation of personal protective equipment continues and today enters a new phase of its development.

Let's also hope that someday, finally, the day will come when manufacturers of bulletproof vests from different countries of the world will be able to agree among themselves, and the long-awaited unified system/method for classifying modern bulletproof vests by their bulletproofness will appear in the world.

Conclusions.

In this review article, using real historical examples, we have tried to trace the evolution of personal protective equipment. This has made it possible to perform a comparative historical analysis of the development of scientific research and industrial technologies, which made it possible to manufacture specific personal protective equipment in a certain historical period.

Also in this review article, we have analyzed the stages of modern technologies that are currently used in the manufacture of various types of bulletproof vest.

And given that the vast majority of authors of publications on the history of the creation of bulletproof vests write that: the bulletproof vest does not have a specific inventor, in this review article we also talk about specific, undeservedly forgotten now, the creators of the world's first officially patented prototypes of bulletproof vests for the police and VIP-persons, at the beginning of the 20th century, who stood at the origins of the bulletproof vest industry.

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The authors declare no conflict of interest.

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Аналіз історії створення та вдосконалення засобів індивідуального натільного захисту: від бронзових обладунків до сучасних бронежилетів

***Анотація.** У цій статті на реальних історичних прикладах автори спробували простежити еволюцію засобів індивідуального захисту. Це дало змогу виконати порівняльний історичний аналіз процесу розвитку наукових пошуків та промислових технологій, які дозволяли у певний історичний період виготовляти конкретні засоби індивідуального натільного захисту. Також у цій оглядовій статті автори проаналізували етапи сучасних технологій, які використовуються на сьогоднішній день при виготовленні різних видів бронежилетів. І враховуючи, що в переважній більшості автори публікацій присвячених історії створення бронежилетів пишуть, що бронежилет не має конкретного винахідника, в цій оглядовій статті автори також розповіли про конкретних, незаслужено забутих нині, творців найперших у світі офіційно запатентованих прототипів бронежилетів для поліції та VIP-персон, на початку XX століття, які стояли біля витоків галузі створення бронежилетів. З розвитком промислової революції та технологічним прогресом, з'явилися нові матеріали та технології виробництва, що дозволяють створювати більш ефективні бронежилети. З часом бронежилети стали все більш легкими та ефективними завдяки використанню нових матеріалів, таких як кевлар, арамідні волокна та кераміка. Таким чином, історія розвитку бронежилетів включає внесок безлічі вчених, інженерів та винахідників, які вносили свій внесок у вдосконалення захисної броні протягом багатьох років. У статті автори показують, що сучасні реалії висувають перед інженерами-конструкторами та виробниками бронежилетів нові вимоги до якості, ваги та функціональних характеристик. Автори статті аналізують основні напрямки, за якими на сьогодні ведуться науково-дослідні роботи з удосконалення бронежилетів. Автори статті показали, що у різних країнах світу існують різні стандарти та*

класифікації для бронежилетів. Кожен стандарт зазвичай має свою класифікацію, яка визначає рівень захисту бронежилету від конкретних видів загроз, таких як кулі, уламки або ножові удари. Тому важливим є завдання розробки єдиного стандарту для сучасних бронежилетів.

Ключові слова: доспіхи; бронежилет; Казимир Зеглен; Ян Щепаник; Стефані Луїза Кволек; кевлар

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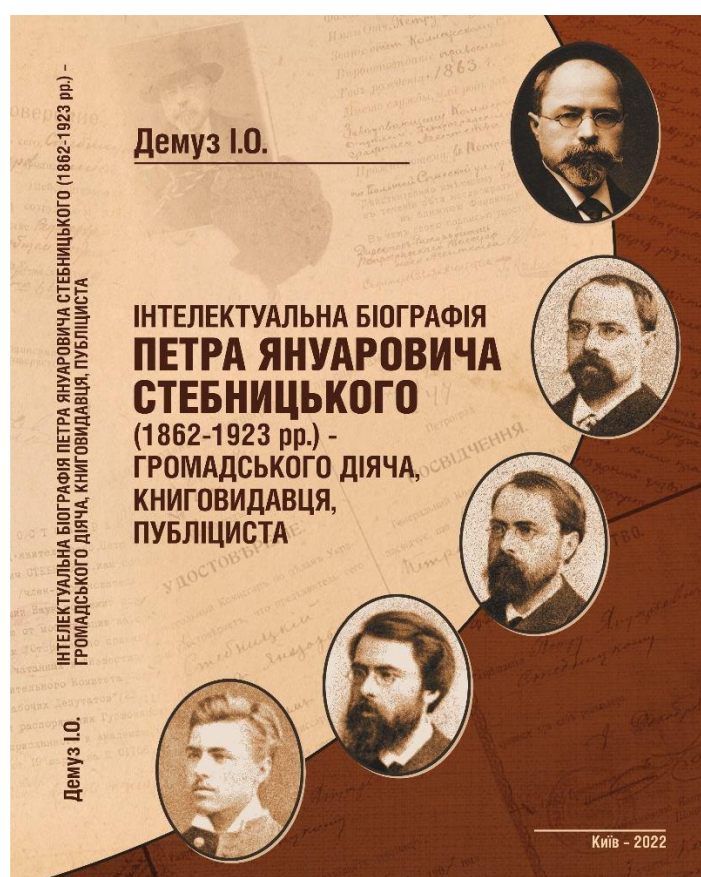
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Review of the monograph: I. O. Demuz. Intellectual biography of Petro Yanuarovych Stebnytskyi (1862–1923) – public figure, book publisher, publicist: monograph. Pereyaslav (Kyiv region): Dombrovska Ya. M., 2022. 356 pp. ISBN 978-617-7747-62-7



In the context of the search for new "anthropological projects", a "biographical turn" in humanitarianism, there is an urgent need to rethink the figure and multifaceted activity of Petro Yanuarovych Stebnytskyi (1862–1923), a builder of the Ukrainian nation, a state builder, and an active participant in the Ukrainian national movement of the end of the 19th and beginning of the 20th century, book publisher, philanthropist and publicist, a new reading of the public figure's personal, professional, and scientific biography. The lack of research on his figure is explained by the fact that during the soviet era, the national intelligentsia was included in the black list of figures of the "Ukrainian bourgeoisie", the very

mentions of which were either removed or were exclusively negative. Despite the appearance of separate studies on P. Stebnytskyi, a number of issues have remained unstudied until now, in particular: the St. Petersburg period of the publicist's activity, his official work in state institutions, a number of committees and unions, as well as public and political life in revolutionary and post-revolutionary Kyiv (1917 – the beginning of



the 1920s); organizational principles of the functioning of publishing houses, in the work of which P. Stebnytskyi was involved, the publicist's contribution to the development of biography, literature, etc.

This topic is relevant not only in the context of biography and portraiture, but also in the direction of the study of historical nation- and state-building processes, the origins of the national self-identification of Ukrainians, a new interpretation of nationally oriented narratives.

It was these research tasks that were realized by Doctor of Historical Sciences, Professor Inna Demuz in a thorough monograph, in which an innovative biographical model was proposed, with the help of which it was possible to represent not only the eventful (classical) biography of P. Stebnytskyi, but also to build his intellectual biography, in particular a mental map of the personality was presented through the method of mental mapping. All this made it possible to depict both the psychological world of P. Stebnytskyi and the Ukrainian-Russian society at the turn of the 19th and 20th centuries in general.

The source base of the research was, first of all, the representative personal fund of P. Stebnytskyi from the Manuscript Institute of the National Library of Ukraine named after V. I. Vernadskyi, an important place in which is occupied by the correspondence and publicist heritage of the public figure.

The scientific novelty of the monograph is indisputable, the structure of the book is logical, such a content structure makes it possible to comprehensively outline the multifaceted activity of P. Stebnytskyi in the field of Ukrainian national affairs.

In Chapter 1 "Theoretical and methodological basis of the reconstruction of the intellectual biography of P. Stebnytskyi", which consists of four subsections, the historiography of the issue, the source base of the research, the methodological principles of building a biographical model are characterized, and a mental map of the actor's biography is constructed, on which places and artifacts are presented, events, people who were significant and played a key role in the life and formation of P. Stebnytskyi's worldview. It was established that the activist belonged to the cohort of those intellectuals of the late 19th and early 20th centuries, whose cultural efforts were focused on the defense of the historical existence of the Ukrainian people, its national and political identity through the development of a communication system in the form of a Ukrainian-language press, education, "Prosvita", libraries, reading rooms, clubs, etc. The author has proven that P. Stebnytskyi was a very versatile, encyclopedically educated person (mathematician by education, held a number of official positions in the Ministry of Finance, was a member of a large number of periodical and magazine editors as a publicist, was interested in the development of trade, agriculture, linguistics, lexicography, wrote poems and literary stories, carried out diplomatic missions, was a member of numerous public and political organizations, worked in scientific academic institutions, engaged in book publishing and library work, was the Minister of Public Education and Arts of the Ukrainian State). The researcher characterized in sufficient detail the intellectual environment with which P. Stebnytskyi communicated: numerous networks of

countrymen, friendships, business, corporate, social and political ties, etc. Thus, his cooperation and personal relationships with public figures D. L. Mordovets, O. G. Lototskyi, E. Kh. Chikalenko, A. V. Nikovskyi, V. M. Domanytskyi, S. O. Yefremov, I. L. Shrag, the Grinchenko, Zhitecki, Rusov families and many others.

In Chapter 2 "Public and political platform of the national idea of P. Stebnytskyi", which consists of three subsections, little-known aspects of the life and activities of the public figure are analyzed: his participation in intellectual, cultural, educational and political centers (in particular, the All-Ukrainian Non-Party Democratic Organization, the Society of Ukrainian Progressives, the Ukrainian Party of Socialist-Federalists, the Ukrainian Democratic Party, the St. Petersburg Ukrainian Club "Hromada", the Ukrainian Parliamentary Community, etc.). For the first time, the researcher has thoroughly analyzed the contribution of P. Stebnytskyi as the head of the Ukrainian National Council in Petrograd in helping refugees and displaced persons during the World War I, as well as his participation in the Ukrainian revolution and liberation struggles of 1917–1921, where he served the representative of Ukraine under the Provisional Government in St. Petersburg, a member of the Financial and Economic Council of the Ukrainian People's Republic, a senator of the Administrative General Court of the State Senate, the Supreme Judge of the Ukrainian People's Republic, the Minister of National Education and Arts of the Ukrainian State, was the deputy head of the Ukrainian peace delegation during the Ukrainian-Russian negotiations of the process between the National Union and P. Skoropadskyi.

In Chapter 3 "Cultural and educational vector of activity of P. Stebnytskyi", which consists of three subsections, the most important direction of activity in the life of P. Stebnytskyi – promotion of the development of national book publishing and distribution of Ukrainian-language printed products is characterized. The public figure during the entire period of existence of the "Charitable Society for Publishing General Useful and Cheap Books" (1898–1918) performed the duties of treasurer, secretary and head of the cell, which enabled this truly innovative and progressive cell to operate in difficult imperial censorship conditions for 20 years of existence, to print a large number of Ukrainian-language books and brochures on economics, law, history, political and public life, agriculture, natural history, medicine, hygiene, veterinary medicine, etc. In the monograph, the author reproduces for the first time a complete list of books published by the society. It was established that P. Stebnytskyi belonged to other publishing houses - "Ukrainian Agronomist", "Drukar". The editorial, lexicographical, educational and librarian activities of the publicist are also highlighted. For example, P. Stebnytskyi was the editor of the Kyiv publishing house "Chas", worked on the editorial board of the collection "Native School" and the bibliographic magazine "Knygar", at the Ukrainian Academy of Sciences, he was the editor of the Permanent Commission for Compiling the Biographical Dictionary of Ukrainian Figures, he headed the Commission for the Creation of the Ukrainian encyclopedic dictionary and dictionary of the living Ukrainian language, participated in compiling the "Russian-Ukrainian dictionary". It was established that the public figure stood near the origins of modern Ukrainian spelling. The publicist

consistently defended the rights of the Ukrainian language in tsarist Russia, was the initiator of the development of a draft law on education. Among the names of the founders of the first National Library in the history of Ukraine (currently the National Library of Ukraine named after V. I. Vernadskyi) is the surname of P. Stebnytskyi. He was a member of the committee since its establishment, developed the first Instruction on the activity of the committee, was the head of the "Ukrainika" department.

The significant contribution of P. Stebnytskyi to the development of Shevchenkiana was studied. The project of publishing the first complete "Kobzar" in the Russian Empire by T. Shevchenko during 1906-1911 was a grandiose creative idea of the nationally minded Ukrainian intelligentsia. The most significant role in the preparation, printing and distribution of the book was played by V. Domanytskyi as scientific editor of "Kobzar" and P. Stebnytskyi as co-editor of the publications.

Chapter 4 "Representation of the "Ukrainian nation-building project" in the legacy of P. Stebnytskyi", consisting of five subsections, analyzes the journalistic and scientific output of the figure, which includes 168 items, includes articles and materials of general economic content; reviews and reviews in the Russian press; articles "about Ukrainian life"; articles, reviews and feuilletons in the Ukrainian press; materials in collections and collective works; materials in separate publications; fiction, poetry, translations. His legacy is generally devoted to issues of national movements and state building in Ukraine, there are literary and journalistic biographies, biographical fiction. The researcher proved that the creative heritage of P. Stebnytskyi affirmed the idea of the individuality of the Ukrainian nation, its right to self-determination and a separate path of development of national culture, had a nation-building, state-building and anti-colonial character. In the creative work of the publicist, issues of socio-economic development of Ukraine were also revealed.

The monograph contains a large number of illustrations (photos of P. Stebnytskyi, prints of his manuscripts, major works, letters, important personal documents, etc.).

The significant search and analytical and critical work carried out by Professor Inna Demuz deserves a favorable assessment. In general, the monograph makes a positive impression both in terms of content, stylistic design, and research methodology. The work will be useful not only for a narrow circle of historians, but also for everyone who is interested in the history of national and public movements in Ukraine, biography and biographical studies.

Conflicts of interest.

The author declare no conflict of interest.

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In search of driving factors of the social processes. Review of the monograph: L. A. Griffen. Missing link. Communication of productive forces and production relations: monograph. Odesa: Kuprienko SV, 2023. 147 pp. ISBN 978-617-7880-34-8

Our time is distinguished by exceptionally turbulent social changes. Today, social processes are taking place at an ever-accelerating pace, which causes an increased public interest in the factors that are the cause of this phenomenon. There is no doubt that they are based on scientific and technological progress, or, in other words, the development of the productive forces of society. However, the desire of researchers to discover a direct connection between the achievements of science and technology and social changes has not been particularly successful – a direct relationship between them is not clearly traced. It is well known that changes in the productive forces lead to changes in the relations of production, and thus in the entire social system. But attempts to identify specific mechanisms that ensure this process have not yet yielded tangible results. However, they continue. The work under review is also devoted to this issue.

The monograph consists of 16 chapters. Its author is a specialist in the field of the history of science and technology, Doctor of Technical Sciences, prof. L. A. Griffen, having analyzed the current state of the issue, accepted as a working hypothesis the existence of such a social phenomenon as the social division of labor between the productive forces and production relations as a link between them. This phenomenon has long attracted the attention of researchers of social processes. However, it itself, recognized by them as an important factor in increasing labor productivity, being a complex and versatile phenomenon, was actually considered only from the indicated point of view. According to the author of this work, the reason for this was an insufficiently clear idea of the object to which this phenomenon refers - society. The author comes to this conclusion as a result of an analysis of existing ideas about society, which he finds insufficiently satisfactory. Therefore, he offers his own idea of it as a biological superorganism that exists and develops in its environment as a certain integrity.

This point is significant, since it characterizes the features of the relationship of society as a kind of self-regulating system with nature, with which society interacts through production processes. They are carried out through two operational social subsystems, which can be defined as its noosphere and technosphere, respectively, "responsible" for the



information and material interaction between society and the environment. From the point of view of Leonid Griffen, both of them include both ideal and material components. The noosphere (public consciousness) is formed on the basis of mental processes in the brain of the individuals that make up the society, united into a single whole with the help of special material formations that bind them – signs. Public consciousness processes information about the environment and fixes it (objectifies) in all material formations (culture) created by society, deobjectifying it as needed. The technosphere, on the other hand, consists of material objects (technical devices) placed by society between themselves and the environment, and “animated” by the consciousness and will of the individuals included in it.

Leonid Griffen shows that the production process, which carries out the interaction of society with nature, in its elementary form is a kind of vertical "chain" that includes a number of components. It begins with social consciousness, which determines the goal of a particular process and the ways to achieve it, perceived by the consciousness of the individual, who through its effectors (organs) through technical devices - tools - influences the object of labor taken from nature, resulting in an object of consumption. At the same time, as an additional effect, the development of the noosphere and technosphere of society takes place, that is, what is commonly called social progress. The positive consequence of the latter is an increase in labor productivity. However, at some point this development leads to a crisis. The information necessary for an individual to fulfill the role of a universal agent of society, due to their quantitative growth with insufficient generalization and structuring, ceases to “fit” in its individual consciousness, which begins to slow down the development of society. According to the author, the resolution of this contradiction was found in the social division of labor.

In the author's opinion, in this case, the production chain mentioned above already includes not one, but several individuals acting in parallel, distributing among themselves various parts of a single technology for the manufacture of a particular consumer item. This "horizontal" division of labor leads to an increase in its productivity. However, in the case of rather complex processes, the mismatch of their components in time and space, with a large number of performers, etc., independent distribution of duties turns out to be ineffective. As a result, another (already consecutive) link appears in the production chain – the individual who organizes this process, i.e., there is also a "vertical" division of labor. And this objectively puts individual individuals in a different position, not only technologically, but also socially, i.e., for the first time, social inequality arises. In the beginning, in a primitive tribe, this difference is insignificant and is more of a situational character. But gradually it is consolidated, on the one hand, increasing labor productivity, and on the other hand, introducing stable relations of social inequality into the previously egalitarian collective, which lead to its significant social transformations.

Leonid Griffen in his monograph argues that at a certain level of social development, this idea acquires a tendency to establish appropriate intercommunal relations, as a result of which one tribe conquers another. A new social organism is being formed with a new type of production processes in which the defeated become performers (the oppressed class

become slaves), and the winners become organizers (the ruling class). In other words, in place of social differences between individuals (and then their groups within the same ethnic group – strata) there are cardinal differences between the main production groups within the framework of a common multi-ethnic social formation – classes. A new era begins in the life of mankind – the era of class society. Based on social inequality, due to the “vertical” division of labor, it immediately sharply increases its productivity due to the synergistic effect. At the same time, all social relations are qualitatively changing – from property relations to ideology – in accordance with the new nature of the social division of labor, which can be traced in detail in the reviewed work.

Basically, the slave-owning states were a kind of "islands" in the sea of barbarian tribes. According to Leonid Griffen, due to higher labor productivity, they had the opportunity to expand territorially, gradually turning into large multi-ethnic formations, later called civilizations. Such expansion increased their power and the wealth of the ruling class. But at the same time it also led to an increase in contradictions with the surrounding social environment and to the disintegration of the slave-owning elite, with the slaves completely disinterested in the results of their labor. Which sooner or later ended in their disintegration under the blows of external forces. Over time, new civilizations arose in their place, consisting of separate feudal states. In them, due to the level of productive forces that had increased by that time, it became possible to individualize them with a corresponding increase in the interest of direct executors in the development of the latter. The feudal states constantly sought to push each other out, but with relative equality in development, the general situation in each region of the Oikoumene remained fairly stable. And so it continued until the end of the fifteenth century, when one of the civilizations suddenly received significant advantages over others.

By this time, Western European Christian civilization, thanks to a favorable climate and a favorable geographical position, had mastered the methods of navigating the high seas, resulting in long sea expeditions that led to the Great Geographical Discoveries, and, accordingly, to contacts with civilizations that were at a lower level of development. The author argues that due to their robbery and exploitation, Western European civilization has dramatically changed its position in the world, becoming dominant and establishing a new, already at the level of civilizations, "vertical" division of labor on the planet. The colonization of the more backward countries by the states of Western Europe began (and first of all by England, which even earlier began this process with the nearby patriarchal Ireland). A new socio-economic formation has been established in the world – capitalism as a global phenomenon. As a result of the exploitation of the colonies, the pace of development of the metropolitan countries increased sharply, which led to the so-called industrial revolution in them, radically dividing the nature of production in these regions of the world for a long time.

This went on for several centuries. Capitalism has significantly accelerated the pace of scientific and technological development of mankind. Of course, this mainly concerned the countries of the West, but to a certain extent it also affected the former colonies, and now “developing countries”. And in the countries of the West, during external integration

processes, the processes of internal differentiation continued, which caused the formation of transnational corporations, which found it more profitable to directly exploit cheap labor in "developing countries". This was done thanks to the industrialization of the latter through the export of capital. At the same time, the rates of their development increased, and in the countries of the West, as a result of their deindustrialization, they decreased. For example, today in the BRICS countries this is 7.5% of GDP growth per year, and in the United States with other Western countries – 2.5%. As a result, many recent "underdeveloped" countries are becoming less technologically and scientifically dependent on the countries of the former mother country, and sometimes even surpass them. And these processes are accelerating, exerting an ever-increasing influence on the entire system in financial, political, social, military and other respects. A global crisis of the international "vertical" division of labor has begun, which is steadily leading to its elimination.

In the history of mankind, this will be the first case of a decrease in the level of the "vertical" division of labor. But scientific and technological progress, and with it the development of productive forces, continues. Moreover, the latter are increasingly characterized by the transfer of production functions previously performed by humans to technical systems. Already today, most operations for direct impact on the object of labor, as well as providing energy for its transformation into an object of consumption, have been transferred to technical systems, which gradually reduces the need for direct human intervention. And the transfer to the latter of the functions of control and management of this process, which are largely associated with the "vertical" social division of labor, began at a rapid pace. As their technical implementation expands, here, too, direct human intervention will decrease, and accordingly, the need for a "vertical" division of labor will gradually disappear altogether. To an ever greater extent, the noosphere will interact directly with the technosphere until these operational social subsystems take over the entire production process, excluding a person from it. And only that which under no circumstances can be transferred to technical systems will remain with a person: general control of the goals and direction of the process, as well as innovation, concludes Leonid Griffen.

This conclusion follows from the author's basic premises. The reasoning given above is rather nontrivial so that a number of questions do not arise. However, it seems to us that they also arouse a certain interest in their peculiar interpretation of scientific and technological progress and its social consequences, which makes it advisable to recommend that specialists in the history of science and technology get a more detailed understanding of them by directly reading this work.

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The author declare no conflict of interest.

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