RESEARCH OF THE MUSICAL AND INNOVATIVE SPHERE IN UKRAINE

[a]HANNA YUFEROVA, [b]YULIIA PALTSEVYCH, [c]TETIANA TUCHYNSKA

[a,c]*R. Glier Kyiv Municipal Academy of Music, 31, Lva Tolstoho Str., 01032, Kyiv, Ukraine*
[b]*Kyiv Municipal Academy of Circus and Performing Arts, 88, Zhylianska Str., 01032, Kyiv, Ukraine*
[c]*Max Planck Institute for Empirical Aesthetics, 14, Grüneburgweg, 60322, Frankfurt am Main, Germany*
email: [a]anna.yuferova@gmail.com, [b]y.paltsevich@edu.kiev.ua, [c]tetiana.tuchynska@ae.mpg.de

Abstract: The relevance of the topic is related to the need to generalization the results of research in the musical and innovative sphere in Ukraine, to reveal scientific ideas for the further development of this area of musicology. The purpose of the article is to summarize the results of research by Ukrainian musicologists on innovations in musical creativity in Ukraine from the 1980s to 2021. General scientific methods of research are applied – analysis and synthesis, description, generalization. A chronological approach was used to study the history of musicological research. The systematic approach made it possible to reveal the results of the natural introduction of innovative technologies into the art of music and outline the vectors of their development. Among the problems that are in the field of attention of Ukrainian musicologists, researchers of the musical and innovative sphere, there are the study of the history of the spread of technical means in music, the understanding of the latest practice of the performer and composer, the development of the methodology of music computer technologies, research on modern techniques of composition: algorithmic, sound synthesis and spatial sound technology, etc. Systematized research data of Ukrainian musicologists L. Dys, I. Haydenko, I. Rakunova, T. Tuchynska, K. Fadeeva, H. Yuferova. These studies focus on the innovations in musical creativity that have taken place over the past decades. A wide range of scientific investigations testifies to the versatile activity of musicologists in the study of modern art and the ways of its development. Computer technologies are an integral part of musical innovation and an important component of the practice of modern professional musicians around the world. In Ukraine, the emergence of the sphere of music innovation technologies took place in the last years of the 1960s, while in the area of special attention of musicologists this sphere came in the late 1980s. Today, the developments in this field constitute a significant body of accumulated experience. The relevance of the topic of the article is related to the need to summarize the topics and results of research in the field of music innovation in Ukraine, to identify key scientific ideas for the further development of this area of musicology.
The purpose of the article is to summarize the results of research by Ukrainian musicologists on the innovations of musical creativity in Ukraine from the 1980s to 2021. The material of the article is the scientific works of I. Haydenko, L. Dys, V. Kaminsky, A. Karnak, E. Kushch, I. Pyaskovs'kyj, I. Rakunova, T. Tuchynska, K. Fadeeva, H. Yuferova and others.

Keywords: Algorithmic composition, Heuristic processes, Musical communication, Musical computer technologies, Music innovation, Sound synthesis technologies, Ukrainian music, Ukrainian musicology.

1 Introduction

After the Second World War, musical art in the world has undergone drastic changes. They are directly related to the technical factor, which gradually penetrated into all spheres of human activity. The introduction of information technologies prompted the search for other methods of making creative decisions, influenced the time-space factors of musical creativity and the professional competencies of musicians. In the middle of the 20th century, experimental music in Ukraine became a real challenge to the musical art of the Soviet regime. Its followers and promoters were young authors, and supporters of musical experiments from the small circle of musicians of the "Kyiv avant-garde". The content of their activities was the study and assimilation of the achievements of the Western European avant-garde, the invention of new forms of artistic expression.

Thus, Vitaly Hodzyac'kyj's piece "4 Scherzi domestici" (1964–1965) based on the noises of household objects became one of the vivid examples of *musique concrète*. A little later, in close cooperation with the Ukrainian Institute of Cybernetics, Leonid Hrabovs'kyj developed his own system for creating algorithmic compositions, which was embodied in his works – in particular, "Homeomorphies 1-3" for piano (1968–1969) and Concerto misterioso for 9 instruments (1977).

The years 1964–1984 were marked by the development of production, which systematically implemented the idea of spreading domestic musical electric instruments. "During this time, Ukrainian engineers designed numerous electromusical instruments: synthesizers ("Altair", "Estradin-230", "Estradin-

3M" ("Gama"), electric organs ("Estradin" series of instruments), rhythm machines ("Pulsar", "Sound"), vocoder-preset ("Krok"), professional digital delay ("Krok Jet"), electroaccordion ("Estradin-084"), etc." [22, p. 58]. Topics of improvement of inventions and methods of new instrument development were discussed at scientific and technical conferences on electromusical instruments. Representatives of not only industrial but also musical organizations were involved in participating in such events held in Zhytomyr in 1971, 1976, and 1981.

Technological progress increasingly fascinated the art of music. The relevance of the study of innovative technologies contributed to the birth of a whole direction of the musicological research. Mykola Dyachenko, Ivan Kotlyarevs'kyj, Ihor Pyaskovs'kyj, and Leonid Dys stood near its origins. Namely, their pioneering scientific position was aimed at introducing information technologies into the system of education of composers and musicologists.

Global changes in the socio-political and economic life of Ukraine in the 1990s not only left an imprint on the further development of musical culture. They coincided in time with communication progress. On the one hand, it is connected with the invention and spread of the personal computer, and awareness of it as one of the tools of creativity and communication. On the other hand, free access to Internet resources became a factor that comprehensively contributed to the integration of Ukrainian music into the world context. Since then, musical creativity has undergone reformatting. The availability of specialized computer software programming methods for musicians and the development of new electronic devices for use in composing and performing practice shifted the emphasis on the morphology of Ukrainian culture. Modern artists widely use electronic technologies – from the development of an artistic idea for a composition, the creation and processing of sound signals, to the fixation and editing of a musical text, the preparation of sheet music for printing, the performance of works in real time, etc. This rooting of innovations in the musician's practice contributed to the activation of the process of studying the problems of music computer technologies. Over the past two decades, musicological thought has been enriched with new important achievements.

The relevance of the topic of the article is connected with the need to generalize the topics and results of research in the musical and innovative sphere in Ukraine, which has been in the area of special attention of musicologists since the end of the 1980s, to systematize the results of already existing research, to scientifically comprehend a large array of practical experimental work in the field of application of musical computer technologies, which took place and continues to develop in Ukrainian music.
The purpose of the article is to summarize the results of research by Ukrainian musicologists on the innovations of musical creativity in Ukraine in the 1980s –2020s, to highlight scientific ideas that are key ones to the further development of a separate direction of Ukrainian musicology.

2 Materials and Method

The material of the article is scientific works on the history, theory, and practice of the musical and innovative sphere. Among them, there are studies of musical computer technologies with the search for methods of musicological analysis (I. Haydenko [6], A. Karnak [8], I. Pyaskovs'kyj [14], I. Rakunova [16], T. Tuchynska [20], K. Fadeeva [5], H. Yuferova [22]); research of modern problems of Ukrainian music (L. Dys [3, 4], E. Kushch [10], E. Moreva [12], S. Shyp [17]); works devoted to the use of computer technologies in the educational environment (A. Bondarenko and V. Shulgina [2], V. Kamins'kyj [9]).

This review summarizes the authors' many years of work on this topic. It had several stages: firstly, collecting information (dissertations, printed articles, work with Internet sources and Kyiv archives, catalogs of Kyiv libraries), secondly, selection and classification of the information received, and thirdly, analysis and conclusions.

The systematic approach and deepening into the analysis of the presented musicological concepts provide an opportunity to identify the results of the introduction of innovative technologies in musical art and outline the vectors of their development. The broad cultural and historical context in which the emergence of scientific ideas is considered covers both the composer's creativity and the facts of the history of the development and implementation of electromusical instruments in Ukraine. This allows us to present the main trends in the development of musical innovation in Ukraine.

3 Results

The large-scale activity of Ukrainian scientists, engineers, and programmers during the 20th century influenced the formation of the national school of programming and ensured the powerful development of cybernetics in Ukraine and the world. At the same time, the development of the industry for the production of electromusical instruments and the establishment of communication links between professional groups, namely scientific-technical and musical, contributed significantly to the rapprochement of the technical and technological component and musical art. Against this background, the research activity of musicologists has become a reflection of progressive thought regarding the informatization of the musical sphere.

The birth of a new branch of music science in Ukraine is associated with the names of Mykola Dyachenko (1928–1993), Ivan Kotlyarevs'kyj (1941–2007), Ihor Pyaskovs'kyj (1946–2012), Leonid Dys (born 1951). On their initiative, the introduction of innovative technologies into educational programs for students of the historical-theoretical and compositional faculties took place.

At the end of the 1970s, in the dissertation "The role of the study of the acoustic factor in the system of analysis of a musical work", L. Dys substantiated the idea of a conducting acoustic horizontal, which was later embodied in computer sound synthesis. This became a kind of analog of the idea of spectral music developed at IRCAM, which is evidence of the concordance of innovative searches of Ukrainian musicians and scientists with European processes. Emphasizing the Ukrainian origin of the term "musical informatics", we note that namely the musicologist L. Dys first introduced this term, and defined musical informatics as "a specific approach within the general system of musicological knowledge" [4, p. 40]. The author considered the objects of study of music informatics to be the means of computer technology, the processes of musical and artistic activity and its results, which are considered from the point of view of musical information. The strategy for the development of music informatics defined by L. Dys, which he saw as a way from the algorithmic representation of the general problems of musical thinking with its gradual detailing and projection onto specific types of musical activity, has not lost its relevance either [22].

Experimental work on the introduction of interdisciplinary connections into the educational process was carried out by associate professor M. Dyachenko together with a team of teachers of the Kyiv Conservatory – I. Kotliarevs'kyj, Yu. Polyans'kyj, O. Murzina, I. Ryabov, S. Tyshko, and L. Shevchenko. Together with I. Kotlyarevs'kyj, M. Dyachenko created an information and search system for a musicologist. His PhD dissertation "Technical teaching aids in the system of comprehensive education of a musicologist" (1984) [15] and methodological development "Principles of programming in an automated solfeggio training course" (1988) [15] became widely known.

The heuristic nature of research methods characterizes the musicological activity of Doctor of Art History, Professor I. Pyaskovs′kyj [3]. The researcher of his creative activity, T. Tuchynska, highlighting the natural modesty and non-public nature of her teacher, emphasizes the large volume of scientific heritage that needs to be understood and carefully studied. The monograph "Logic of musical thinking" (Kyiv, 1987), a manual on polyphony for higher musical institutions (Kyiv, 2003), articles on the phenomenon and evolution of musical thinking, problems of musical semiotics, computer analysis and synthesis of musical texts belong to the fundamental research of Pyaskovs′kyj. Thanks to Pyaskovs′kyj, since the second half of the 1990s, musicologists of the National Music Academy of Ukraine named after P. I. Tchaikovsky are studying the author's discipline "Computer analysis of musical works", which includes the methodology of probabilistic-statistical analysis of musical text, modeling of melody based on Markov chains, practical use of frame models in the analysis and modeling of musical styles.

The sphere of interests of the correspondent member of the Academy of Arts, honored worker of science and technology of Ukraine, doctor of art history, professor I. Kotlyarevs'kyj covered a wide range of scientific problems: music-theoretical, aesthetic, cultural, and scientific-methodological. On the initiative of Kotlyarevs'kyj, information and computing center was opened for the first time in Ukraine on the basis of the Kyiv Conservatory in 1987. L. Dys [15] became the scientific director of the created center. In his lectures on music informatics (1988), the scientist indicated the real possibility of using computer technologies as training equipment in the field of practical composition, and emphasized the prospects of using computer technologies in musicology, music performance, and pedagogy [3, 4].

The emergence of such a creative center contributed to the powerful development of modern composing technologies. Therefore, it is not surprising that a number of successful composers appeared over the years - A. Zahajkevych, M. Abakumov, O. Voytenko, O. Retinskyj, M. Shalygin, whose electroacoustic works are known in Ukraine and beyond.

Since the beginning of the 2000s, the educational unit "Musical computer technologies" at the Kyiv Municipal Academy of Music named after R.M. Glier, one of the leading musical educational institutions of Ukraine, became a real experimental scientific and practical platform of musical and innovative direction. The innovative work of teachers O. Voytenko, V. Lazareva, A. Roschenko, T. Tuchynska, H. Yuferova is connected with a number of experimental activities involving students. Among them, there are the study of the processes of musical communication using the example of several models of interconnection [22], the study of the processes of creating an algorithmic composition and the perception of author's and machine music [20]. The experience of such activities is summarized in scientific articles [12], educational programs of author's disciplines[1], methodical manuals and textbooks on music informatics [2].

In the course of the first twenty years of the 20th century, a solid basis for the study of individual areas of application of musical computer technologies according to global directions, which exist in their close relationship, appeared. Thus, in the Ukrainian space, these studies are represented by the works of A. Karnak (2000), I. Haydenko (2005), I. Rakunova (2008), K. Fadeeva (2009), T. Tuchynska (2009), E. Kushch (2013), H. Yuferova (2021).

In his dissertation "Tradition of experiment in American music of the 20th century", A. Karnak, investigating the evolutionary-historical and technological aspects of the creative process of such composers as J. Cage, E. Varese, M. Feldman, V.

---

[1] For example, discipline programs for students of the KMAM named after R.M. Glier: "Fundamentals of musical informatics", "Computer technologies in musical art", "Synthesizer arrangement stations" (H. Yuferova), "Fundamentals of computer arrangement" (T. Tuchynska), and others.

Usachevsky, O. Luening, discovered insufficient development of clear criteria for evaluating phenomena associated with the tradition of experimentation. The researcher focuses on the fact that an important factor in the holistic analysis of experimental and innovative examples of composer creativity is the use of literature from various fields of knowledge: mathematics and computer technology, information theory and cybernetics, phenomenology, linguistics and semiotics, semantics, philosophy of music, meditative practice and Oriental studies [8]. Studying samples of experimental music created with the use of technical means, almost for the first time, Ukrainian scientists faced the question of the impossibility or ineffectiveness of musicological analysis in the traditional sense. The main problem was that each work is unique from the point of view of the dialectic of music and computer technology. Therefore, further research by scientists was directed into the field of the experimental analysis of the technology of the creative process, which is sometimes impossible without the composer's comment.

The study of the role of musical computer technologies and the peculiarities of their use in the creative process is related to the issues of I. Haydenko's dissertation "The role of musical computer technologies in modern compositional practice" [6]. The author focuses on the peculiarities of the use of information technologies in composers' creativity and considers computer technologies as a basis for a new type of creative thinking on the examples of the works of representatives of modern foreign and Ukrainian musical culture. The researcher emphasizes the structural and functional similarities between compositional techniques and music computer technologies: they are both ways of creating music by a person, and the difference lies only in their nature. While compositional techniques do not go beyond the boundaries of human activity, musical computer technologies are their reflection in human consciousness, embodied in software and hardware. Musical computer technologies first accumulated the properties of compositional techniques and then began to influence musical composition themselves.

Investigating computer technologies and new creative musical possibilities on the example of the activities of IRCAM (Paris, France), I. Haydenko singles out the main directions of development of the field of music computer technologies that are directly related to composer practice, including the research direction on sound synthesis, creating music, developing computer equipment and specialized computer programs, etc.

The development of analytical methods for the study of electroacoustic compositions remains an urgent issue for Ukrainian musicologists. Researchers repeatedly addressed this topic [2, 9, 16, 17, 20], but each time the author's idea of electroacoustic and electronic music was adjusted according to the ideas of the researcher himself. This tendency is maintained due to terminological desynchronization between different schools of musicology. The author of the term *electronic music*, V. Meyer-Eppler, used it to define compositions created using electromechanical or purely electronic sounds. In the USA, for example, under the term *electronic music*, as noted by V. Kamins'kyj, "< ...> all derivatives and directions close to it, such as concrete music, *Music for Tape* and others, have been united, without causing terminological confusion and ambiguity <...>" [9, p.35]. In our opinion, the term *electronic music* only indicates the technology and does not establish stylistic restrictions, as well as genre restrictions. Such an opinion coincides with the reasoning of such an authoritative researcher of electronic music as L. Hiller. He noted that there is no difference in approaches to the process of creating music, but there is a difference in the means that the composer chooses for this. When creating symphonic music, he must work with orchestral means; instead, for a piece of music to be electronic, its author must provide for electronic sound generation, processing with effects, etc.[2] In agreement with L. Hiller, S. Shyp (Ukraine) calls electronic music the one "the material basis

of which is electronically produced, prepared, and synthesized sounds" [17, p. 146]. Such a definition, in our opinion, should be taken into account by scientists, as it is quite clear, comprehensive and does not create other meanings.

The term *electroacoustic music* has a broader meaning than the term *electronic music*. Emerging in France in the late 1950s as a result of a combination of compositional techniques and a concrete and electronic approach to sound, electroacoustic music today is entirely related to the use of computer software. Historically, it so happened that in some European countries the term *electroacoustic music* encompasses concrete, electronic music, psychoacoustics, acousmatics. Electroacoustic music also includes computer music and its branches - interactive, algorithmic, stochastic, and experimental music [22].

The dissertation research of I. Rakunova "New compositional technologies (on the example of the work of Alla Zahajkevych)" [16] is devoted to the issue of the use of electronic technologies in the process of creating electroacoustic compositions.

The musicologist examines the history of the development of electronic technologies, the history and theory of algorithmic composition, researches sound synthesis technologies, etc. The technology of sound processing in real time is investigated by I. Rakunova using the example of A. Zahajkevych's work "Pagodas". At the same time, another work of the composer – "Air Mechanics" - became the subject of studying the features of algorithmic composition. The work is analyzed with an emphasis on its connection with the "Computer Assisted Composition" technology (compositions using a computer[3]).

Among the types of synthesis used by A. Zahajkevych in the electroacoustic work "Heroneia", wave-table synthesis and granular synthesis are distinguished. In addition, it was found that the author widely implements the effects of instrument sample processing - reverberation, various filters, skillfully using the functionality of computer programs, including Super Collider Sound Hack and others.

The basis of Rakunova's multifaceted research is an attempt to find the correct application of modern computer technologies, to determine their place in the creative process, as well as in its analysis. So, among the most important problems facing the musicologists of the world today, the researcher includes such as the development of a unified analytical terminology, the development of effective methods and tools for the analysis of electronic works, and the study of the processes of musical creativity with the help of mathematical models. Studying the electroacoustic works of Zahajkevych, Rakunova proves that the main question of musicological analysis is that each work is unique from the point of view of the dialectic of music and computer technology. Therefore, it seems possible to identify certain common features and relationships only from the standpoint of using certain technologies or computer programs. Everything else is the sphere of experimental analysis of the creative process technology.

4 Discussion

The problem of the existence of the limits of the computer' creative possibilities, which was touched on in the works of D. Oppenheim, I. Pyaskovs'kyj, the questions about the measure and ways of identifying the individual author in the compositions created with the help of a computer, raised in the works of I. Haydenko and I. Rakunova, the relationship between the personal-composer' and the machine' were continued in the research of Ukrainian musicologists in the early XXI century. Tuchynska's dissertation study "Understanding a musical text: theoretical and informational aspect" is devoted to algorithmic composition, its essence and software implementation [20]. The researcher studied the problem of formalization of the process of understanding the musical text and the frame approach to modeling the composer's style using the example of the work of

---

[2] Hiller, L.A. (n.d.). *Electronic music. An Encyclopaedia Britanica Company.* https://www.britannica.com/art/electronic-music

[3] The technical solution is implemented on the basis of the PatchWork program

the Ukrainian composer V. Silvestrov. The paper considers an algorithmic composition program capable of generating musical texts in a given style using stochastic and combinatorial principles. Tuchynska conducted an experiment on the perception of music created with the help of algorithmic composition programs and by authors (both professional composers and amateurs). In this way, the researcher found out whether it is possible to detect during auditory perception the difference between the author's music and compositions that are generated using computer programs.

The experiment showed that at the time of music playback, the listener is unable to distinguish, as a result of which process, stochastic or deterministic, certain musical fragments were created with the help of algorithmic composition programs. This happens because the most important essential features of the composer's music and a significant part of its semantic component cannot be formalized, so there is an inevitable loss of part of the information. Such conclusions demonstrate the impossibility of complete algorithmization and formalization of the creative process.

Tuchynska also studied the issue of computer programming regarding the analysis and synthesis of both individual sound elements and musical compositions. The researcher concluded that to achieve the goal of programming, the creation of conditions for self-organization of the system and autonomization of actions, which model the processes of creating a musical composition without direct human participation, is assumed. This is because a person is excluded from the composition process itself, and is involved only in the initial and final stages of the process, as an initiator and an expert. "Such modeling allows revealing the objective regularities of sound organization, which also operate in the process of creating a musical composition by a human, which implies his inclusion in the communicative process of understanding" [20, p.15].

K. Fadeeva's attention was focused on heuristic processes in musical creativity with the help of computer software and the peculiarities of their manifestation, in the work "Modern computer technologies in the study of musical culture" [5]. The author reviewed the evolution of the development of innovative technologies, which preceded the emergence of the computer and the spread of electronic technologies in particular. In the context of the study of musical creativity, the areas of application of artificial intelligence methods are emphasized. For the first time in Ukraine, a review of the history of the development of music computer programs from game development to virtual sound studios was carried out. The researcher studied theoretical assumptions regarding the analysis of structure samples and individual functions of some computer programs, and classified educational music computer programs, which she proposed to divide into expert and non-expert.

The field of musical computer technologies became the object of research by Yuferova [22]. Conducting work on the study of communication processes of modern Ukrainian music is conditioned by the fact that the role of musical computer technologies in them remained uncertain for a long time. In addition, the insufficient development of the theoretical base of the musical and innovative sphere slowed down the understanding of the specifics of modern musical communication processes and somewhat restrained the development of Ukrainian musical art.

In the process of research, the author identified three stages of the history of the musical-innovative sphere, namely preparatory (1857–1945), progressive (1945–1990), and the latest (1991–present). The main factors of the formation of the field at the preparatory stage were studied and the characteristic signs of development at the progressive stage, which led to the emergence and spread of music computer technologies in Ukraine and the world, were determined. Among them, there is the establishment of electronic music studios in Europe, the USA, and Japan [7], the spread of information theory, the emergence of a method of digital data processing, the discovery

of effective algorithms for calculating Fourier transforms (Fast Furrie Transform, FFT), modernization of hardware and software against the backdrop of the microprocessor revolution and the accumulation of innovative methods in music computer software.

For the first time in musicology, theoretical provisions regarding musical computer technologies have been developed. Yuferova formulated the definition of the concept of "musical computer technologies", which is fixed in Ukrainian musicology as a system of knowledge and communicative practices connected with the use of modern personal computers as one of the tools of musical creativity and communication.

The author singles out five areas of the system of music computer technologies. Among them, there are the following: multimedia technologies, graphic technologies for musical score, sound programming technologies; digital sound technologies; virtual studio technology (VST). In determining the directions of music computer technologies, the principle of combining software tools around separate technologies that provide solutions for a related range of tasks is taken as a basis. Thus, multimedia technologies include multimedia editors for creating video content; media players for playing, storing, and organizing audio and video files; converter programs and codecs; training programs and simulators; CD/DVD burning applications. Graphic technologies for musical scores include software complexes for creating and editing musical material, voicing scores, and preparing sheet music for printing (Dorico, Finale, MuseScore, Sibelius). Sound programming technology includes graphic environments and programming languages for working with audio and video, the purpose of which is to create an algorithmic composition, synthesis and processing of sound, generation of sound objects, and processing of sound during a concert performance (Max MSP, Pure Data, etc.). Digital sound technologies include sound editors; programs for analysis and graphic presentation of sound and sound events; digital workstations and sequencers (Ableton Live, Steinberg Cubase, Logic Audio, Reaper). Virtual studio technology includes VST-tools for voicing scores and creating electronic sounds (Native Instruments Kontakt Player, Spectrasonics Omnisphere, etc.) and VST-effects that provide sound processing (iZotope Ozone, Ambisonics, FabFilter, etc.).

The realization that the theoretical basis of music computer technologies is based on scientific knowledge of music informatics and is a part of musicological knowledge made it possible to investigate the innovative link of musical art and to reveal the regular results of its functioning. The study of musical computer technologies as a systemic phenomenon, from the perspective integrated with the processes of musical communication, opened the way to understanding the globality of its influence on the modern development of Ukrainian musical art. Having manifested itself in the spiritual and creative activity of society, the system of music computer technologies has ensured real changes in the art of music thanks to: the acceleration of the process of perception and understanding of information, reaction and generation of meanings in the listening environment, renewal of means and forms of musical expression, provision of new tools for creativity and communication, as well as expanding the professional competence of musicians and integration of modern Ukrainian musical culture into the global media space [22].

For the first time among Ukrainian musicologists, Yuferova used spectromorphological analysis [18] of compositions by the auralf sonology method of Lasse Thoresen[4] [1, 19] as a component of musicological analysis for research analytical work. Such integration ensured compliance of the tested analytical method with the requirements for solving the task of learning the artistic logic of acoustic and electroacoustic works (with and without a

---

[4] To solve such a task, the specialized software tool Acousmographe (Aural Sonology plugin) was used. The dynamic profiles of the works were analyzed. A spectromorphological analysis of the musical fabric of the compositions was carried out with the help of graphic markings of the corresponding abstract models of sound objects, textured layers, etc.

score). The process is demonstrated with the involvement of computer software on the example of the study of chamber works by Ukrainian composers A. Zahajkevych, O. Voytenko, and co-authors - Cherny / Tuchynska / Yuferova. Knowing the artistic logic of each work in this case made it possible to formulate the main artistic ideas of the compositions. Emphasizing the spiritual continuity of generations distant in time and space, A. Zahajkevych in the work "Mithe IV: K.S." reveals the idea of the infinity of creative burning as the infinity of creative life. The artistic idea of O. Voytenko's work "Homo fugens" consists of the composer's creation of a model of a multidimensional musical chronotope as a special, heightened sense of movement, time, and space. The artistic idea of the composition of the Cherny / Tuchynska / Yuferova group of authors "Spinning Universe" is to create an original musical spherical space, where electronic (modern) and acoustic (authentic) sounds coexist in time, provoking the listening sensation of continuous, as if in a state of trance, spinning in space of the Universe (implemented with Ambisonics).

The use of spectromorphological analysis by the aural sonology method of L. Thoresen ensured the creation of unique graphic scores. This helped to reveal certain regularities in the development of the elements of the musical fabric and to formulate intermediate and final conclusions with an emphasis on the formulation of the main artistic idea of each work.

5 Conclusion

Despite the global technology boom that unfolded in recent decades, as well as the rapid pace of integration of music and electronic technologies, Ukrainian musicology managed to avoid the formation of a vacuum regarding the study of innovative processes. In a short period, scientific work on the introduction of the latest methods into the musician's practice was organized. Undoubtedly, science has been lagging behind practice for some time, since scientific research itself, with the organization and conduct of experiments and the formulation of well-considered and thorough conclusions require a certain amount of time to be understood.

Summarizing the above, we confirm the fact that Ukrainian musicologists have studied a wide range of issues related to the history, theory, and practice of the musical and innovative sphere. Among the researched topics of the historical direction, there is the coverage of facts regarding the emergence, development, and penetration of innovative technologies into musical art (Rakunova, Fadeeva), the understanding of certain periods of the history of the musical and innovative sphere (Yuferova). Among the topics related to the problems of the practical application of music computer technologies, there are several studies on individual composing techniques (Haydenko, Tuchynska), technologies of processing and transformation of sound material (Haydenko, Rakunova), the field of digital sound processing (Rakunova, Fadeeva), features of algorithmic composition creation, music with spatial localization of sound (Rakunova, Tuchynska, Fadeeva, Yuferova).

Among the theoretical issues investigated by Ukrainian musicologists, the most important ones are the development of methods for solving analytical problems using samples of electroacoustic music (Haydenko, Rakunova, Yuferova), the study of artificial intelligence methods (Tuchynska, Fadeeva), the study structural and functional analysis of systems for fractal and algorithmic composition using PatchWork, OpenMusic, Fractal Music (Fadeeva, Haydenko).

Special attention of scientists was directed to the study of such areas as sound synthesis (Rakunova), musical programming (Tuchynska, Fadeeva), and graphic technologies for musical scores (Haydenko). Confident steps have been taken in the development of the research methodology for the musical and innovative sphere (Yuferova), in particular, the structural and functional analysis of computer MIDI sequencer programs (Fadeeva) and the use of computer systems in music science and pedagogy (Haydenko, Yuferova). The role of musical computer

technologies in the communication processes of modern Ukrainian music, which is defined as global (Yuferova) [22], is studied.

The achievements of Ukrainian musicology regarding the development of major issues in the field of music computer technologies over the past decades are quite significant. The practical value of the research mentioned in the article is undeniable. At the same time, we have to admit that there are still topics that are sensitive enough for musicological science that remain outside the attention of scientists. For the most part, they concern related sciences and, therefore, require the involvement of specialists from other professional groups. So, for example, various aspects of musical acoustics, processes of digital generation of tones, and creation of musical compositions based on them can be studied. Special attention can be paid to the study of aesthetic experience, and musical perception with innovative technologies and empirical methods. Also, the invention of new methods of teaching information technologies in the process of professional training of young musicians requires additional development.

Literature:

1. *Aural Sonology: Emergent Musical Forms*. http://www.aurals onology.com/.
2. Bondarenko, A., & Shulgina, V.D. (2011). Music informatics. Kyiv: NAKKKIM.
3. Dys, L. (1988). *The use of computers in music education. Lectures.* Kyiv: Kyiv State Conservatory.
4. Dys, L. (1988). *Fundamentals of musical informatics. Lectures.* Kyiv: Kyiv State Conservatory.
5. Fadeeva, K. (2009). Modern computer technologies in the study of musical culture. PhD thesis in art history. Kyiv.
6. Haydenko, I. (2005). The role of musical computer technologies in modern compositional practice. PhD thesis in art studies. Kharkiv.
7. Holmes, T. (2008). *Electronic and experimental music: technology, music and culture* (3rd ed.). NY: Routledge.
8. Karnak, A. (2000). Tradition of experiment in American music of the 20th century. PhD thesis in art studies. Kyiv.
9. Kamins′kyj, V. (2000). *Electronic and computer music: education.* Lviv: Spalah.
10. Kushch, E. (2015). *Electromusical instruments as an evolutionary factor of musical culture.* Kyiv: NAKKKiM.
11. Moles, A., Fuchs V., & Kassler M. (1975). *Art and computers.* Moscow: Mir.
12. Moreva, E. (2008). To the problem of translation of special terminology in sheet music editors. *Music in the information society. Scientific Bulletin of the National Music Academy of Ukraine named after P. I. Tchaikovsky, 79,* 17–27.
13. Pyaskovs′kyj, I. (2002). To the problem of computer modeling of the composer's creative process. Scientific Bulletin of the National Music Academy of Ukraine named after P. I. Tchaikovsky. *Musical Work: Problems of Understanding, 20,* 33–44.
14. Pyaskovs′kyj, I. (2004). Computer methods of analysis of musical texts. *Ukrainian Musicology: Science and Method, 33,* 131–143.
15. Pyaskovs′kyj, I. (2002). A historical and biographical sketch of the activities of the teachers of the Department of Music Theory named after N. P.I. Tchaikovsky. *Scientific Bulletin of the National Music Academy of Ukraine named after P.I. Tchaikovsky. Series "A musical piece as a creative process", 21,* 132–153.
16. Rakunova, I. (2010). *New composing technologies: Alla Zagaykevich's work.* Kyiv: Phoenix.
17. Shyp, S. (1984). Electronic music: problems and prospects. Music criticism and modernity. *Musical Ukraine, 2,* 141–158.
18. Smalley, D. (1997). Spectromorphology: Explaining sound-shapes. *Organised Sound, 2*(2), 107-126.
19. Thoresen, L., & Hedman, A. (2007). Spectromorphological analysis of sound objects: an adaptation of Pierre Schaeffer's typomorphology. *Organised Sound, 12*(2), 129-141.
20. Tuchynska, T. (2009). Understanding the musical text: theoretical and informational aspect. PhD thesis in art studies. Kyiv.

21. Voloshyn, V., & Fedorchuk, L.I. (1971). Electrical musical instruments. Series Mass radio library. Moscow: Energy, Issue. 773.
22. Yuferova, H. (2021). Musical computer technologies in communication processes in contemporary Ukrainian music. PhD thesis. NMAU named after P.I. Tchaikovsky. Kyiv, SumDPU named after A.S. Makarenko, Sumy.

Primary Paper Section: A

Secondary Paper Section: AL