Musical Informatics as a Resource for Training in Professional Activity of a Music Teacher

Elena Bazhukova, Sergey Chibirev, Irina Gorbunova, Andreas Kameris

***Abstract*—** Despite the fact that musical informatics was formed as a separate field of knowledge in the 70s of the 20th century and exists as an educational discipline in universities in many countries of the world, an orderly system of its teaching has not yet developed in our country, there is no well-established, formed representation and definition of the concept of "musical informatics" in the educational and content aspects. As approximations to the solution of these problems, we note the fundamental works of A. V. Haruto ("Musical Informatics," "Computer analysis of sound in music science") and a number of other employees of the Tchaikovsky Moscow State Conservatory, among whom we note the curriculum for the discipline "Musical Informatics", compiled by the composer A. N. Ananyev. Also, a significant contribution to the process of establishing the foundations of this discipline was made by V. S. Ulyanich (Russian Academy of Music named after Gnesiny), S. P. Polozov (Saratov State Conservatory named after L. V. Sobinov), previously – Yu. N. Rags (Moscow Conservatory, State Music and Pedagogical Institute named after Gnessiny), A. P. Mentyukov, A. A. Ustinov, S. A. Cheldiev (Novosibirsk State Conservatory named after M. I. Glinka). A significant contribution is also contained in the works of A. A. Korolev "Musical and computer dictionary" and "Free computer programs for a musician" (St. Petersburg State Conservatory named after N. A. Rimsky-Korsakov).

The purpose of this article is to present a certain order of presentation of the discipline "Music Informatics", which most closely corresponds to the current state and level of development of digital and music computer technologies (MCT) expressive means in musical and artistic culture.

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I. Introduction

In the middle of the 20th century, musicology and related sciences proposed a number of promising ideas containing ample opportunities for the study of mathematical research methods in musicology and partially ahead of similar ideas in the field of exact sciences. The article discusses a number of methods for studying the laws of music, as well as provides developments on the application of these methods in music teaching practice.

The authors of the article pay special attention to music computer technologies (MCT), which were developed at the turn of the 20th – 21st centuries as a means of studying music within the system of contemporary musical education at its various levels – professional and additional professional. The article also highlights some problems related to the development of probabilistic and statistical laws of music, including the logic and technique of musical composition. In the Herzen State Pedagogical University of Russia in 2002, the first Education and Methods Laboratory *Musical Computer Technologies* was created in the Russian Federation, in which the symbiosis of musicians of various specialties, mathematicians and programmers helped to form the subject content of the discipline "Musical Informatics". Comprehensive research and scientific and methodological developments undertaken by the staff of the *Music Computer Technologies* Laboratory at the Herzen State Pedagogical University of Russia, which served as the basis for the development of music informatics as a field of scientific knowledge and academic discipline and influenced the musical culture of the beginning of the 21st century, are characterized.

II. Phases of the Formation of Musical Informatics as a Field of Subject Knowledge

Musical informatics and the idea of musical informatics as a separate field of knowledge was formed by the end of the 70s of the 20th century. Already at this time, the term "musical informatics" is found in the works of prominent experts in the field of electronic and computer music: Zh-K. Risse (France), J. Chauning (USA), G. M. Koenig (Netherlands), R. Ruziczki (Czechoslovakia), J. Xenakis (France), etc. Sound research centers with the use of computer technologies are being opened

in the USA: Massachusetts Institute of Technology; Centre for Computer Research in Music and Acoustics at Stanford University; Center for Musical Experiment at the University of California, San Diego; International Institute of Electroacoustic Music (Bourges, France); Center for New Music and Audio Technologies in Berkeley (California, USA); Danish Institute of Electroacoustic Music; Theremin Center for Electroacoustic Music and Multimedia (Moscow, Russia) and others . At the IRCAM Institute (IRCAM - Institute for Research and Coordination of Acoustics/Music, Paris, France) in the 80s. The discipline "Musical Informatics" has been developed and introduced into the educational process. In the future, musical informatics becomes one of the program disciplines taught in educational institutions in many countries of the world.

In Russia, the teaching of the discipline "Musical Informatics" begins to be gradually introduced into the educational process at the end of the 20th century. Thus, by the mid-1990s, musical informatics was taught in a number of musical educational institutions of the country, including the Tchaikovsky Moscow State Conservatory (musicologist Yu. N. Rags, specialist in music and information technologies A.V. Haruto), the Novosibirsk State Conservatory named after M. I. Glinka (A. P. Mentyukov, G. V. Mikhailenko), St. Petersburg State Conservatory named after N. A. Rimsky-Korsakov (musicologist M. S. Zalivadny, mathematician-programmer V. R. Petryaevsky), Gnessin Russian Academy of Music (composer and musicologist, mathematician-programmer V. S. Ulyanich).

In the period of the late 1990s - early 2000s, the discipline "Musical Informatics" is conducted sporadically, its content is determined by specific technical conditions and opportunities for teaching it in each individual educational institution (the presence of a classroom equipped with specialized music computers and equipped with professional software), as well as the level of knowledge of the teacher.

Music computer technologies and their role in the formation of the course "Musical Informatics" in Russia

In the early 2000s, due to the formation and development of MCT, the discipline "Musical Informatics" receives a new impetus to development. In 2002, at the Herzen State Pedagogical University of Russia the first in the Russian Federation Education and Methods Laboratory *Music Computer Technologies* is being created, uniting musicians of various specialties, mathematicians and programmers, which provided the necessary prerequisites and formed an active basis for building a competent, balanced, subject-based content of the discipline "Musical Informatics", its standardization and inclusion of this discipline in the modern educational standards of higher musical and pedagogical institutions of the country. So, on the basis of the Laboratory, dissertation research was conducted and candidate dissertations were defended in the specialty "Theory and Methodology of Teaching and Upbringing" (computer science, levels of general and vocational education), which address the issues of teaching the discipline "Musical Informatics" (and its content components) at various levels of education:

− primary vocational education (children's music schools, children's art schools – dissertation research: "Operational Knowledge in Computer Science of High School Students of Musical Profile on the Basis of Music Computer Technologies" (A.V. Gorelchenko, 2007), "Methods of Teaching Computer Science to Music School Students Using Sound Software and Hardware Complex" (M. Yu. Chernaya, 2012), "Methods of Teaching Computer Science Using Music Computer Technologies at the Propaedeutic Stage of General Education" (K. Y. Plotnikov, 2015);

− secondary professional education: "Formation of Information Competence of Future Musicians in the Process of Learning Computer Science" (E. A. Lozhakova, 2012);

− higher professional education: "Methods of Teaching the Basics of Music Programming" (E. V. Kibitkina, 2011), "Teaching Computer Science in the Process of Training Music Teachers of Secondary Schools in a Pedagogical University" (A. A. Pankova, 2016).

The discipline "Musical Informatics" and new requirements for the level of training of a modern teacher of musical disciplines

In music educational institutions of the initial level, the discipline "Musical Informatics" is included in additional pre-professional general education programs in the field of musical art; in pedagogical colleges, colleges of arts, music and music pedagogical colleges, the curriculum for the discipline "Musical Informatics" is included in the main section of the professional educational program; in higher educational institutions, the discipline "Musical Informatics" it is introduced into the professional cycle of general professional disciplines of the work plan. Coordination of methodological content in this discipline is still practically absent, as a result of which knowledge on this subject is spontaneous, not systematized.

The emergence of digital tools in music education imposes new requirements on the level of training of a modern teacher of musical disciplines, creates the need to develop new abilities for him to work quickly and efficiently with musical information, analyze, process and transmit the results obtained using information technology. A range of problems regarding the state of knowledge in the field of musical informatics has been identified, namely the need to overcome the formalism of this knowledge among music teachers, which complicates the introduction and use of digital tools and resources in the system of contemporary musical education.

Contemporary specialists in the field of music require knowledge from the field of computer science, mathematics and physics, including:

• theory of sound, fundamentals of acoustics and psychoacoustics (including mathematical elements, since programs modeling acoustics are based on them – without understanding these elements, it is impossible to correctly configure and use such programs in this process);

• basic concepts of computer science, which include the main types of hardware (specialized music-digital and hybrid equipment), types and logic of the device and interface,

software, principles of file systems (files and basic operations with them), etc.;

• fundamentals of programming, which can be meaningfully presented in a professional aspect – through musical programming languages (for example, MIDI, etc.), on the use of which, for example, the work of sequencers operating with musical events, and not wave music files (for example, WAV, etc.) is based; fundamentals of sound-timbral programming, musical programming, etc.;

• fundamentals of mathematical and computer modeling (to the extent necessary to understand the methods of modeling sound synthesis and its implementation by computer musical means);

• basic concepts of signal processing (to understand various methods of sound synthesis and analysis).

What is the content of the concept of "music informatics" today? As it was noted earlier, music informatics and the idea of music informatics as a separate field of knowledge were formed by the end of the 70s of the twentieth century. However, there is still no unity in the definitions of this concept. To this end, let us turn to the origins of the concept of "computer science" and its further evolution. As you know, the term "computer science" was introduced by a German specialist in the field of cybernetics K. Steinbuch in 1957 in the work "Computer Science. Automatic information processing." In French, this term appeared in 1962 and was recognized by the French Academy of Sciences as a "new word" in 1966, at the same time in the USSR, electronics specialist A. A. Harkevich proposed the terms "informology" and "informatics" to denote science that generalizes the patterns of information information. Harkevich's work "The Basis of Scientific Information" appeared in 1965, later it was republished under the title "Fundamentals of Computer Science" (1968).

The term "computer science" and "musical informatics" are closely related to the concept of "information". Therefore, in this chapter we consider it necessary to pay special attention to the concept of "information".

Academician A. P. Ershov was one of the first programmers in Russia with a professional education in the field of knowledge under consideration. He formulated the following definition of computer science: "Computer science is the name of a fundamental natural science that studies the processes of transmission and processing of information."

In English-speaking countries, the term "informatics" (which means "computer science") has come into use to denote the science of information transformation, which is based on the use of computer technology.

Computer science and computer technology in modern conditions are inseparable. Today, the term "musical informatics" refers to the section of computer science that studies the features of processing musical information, including the technical and software tools with which such processing is performed.

In this regard, we can conclude that it is necessary to overcome formalism in training in musical informatics using the capabilities of contemporary music computer technologies (MCT) [1; 2].

III. CURRICULUM OF THE “MUSICAL INFORMATICS” DISCIPLINE

The overall conclusion on the curricula analysis of "Musical Informatics" of primary, secondary and higher-level institutions [3-8]. In connection with the development of MCT and digital musical instruments [9], the discipline "Musical Informatics" requires a change in content, since new requirements are placed on the music teacher, namely, the ability to conduct educational activities using digital technologies.

The thematic plan should be aimed at developing skills in working with information and communication technologies and motivate the music teacher to independently obtain knowledge in this field using MCT and a musical synthesizer.

In the "Musical Informatics” course of the study, there was identified the thematic plan for training in music informatics containing the following topics:

- Topic 1. *The Subject of Musical Informatics*
- Topic 2. *Music, Mathematics, Computer Science: Facets of Interaction*.
- Topic 3. *Architectonics of Acoustic and Digital Musical Sound.*
- Topic 4. *Musical Synthesizers*.
- Topic 5. *Sound Synthesis Technologies*.
- Topic 6. *Musical Computer*.
- Topic 7. *Digital Musical Synthesizer as a Modern Software and Hardware Complex for Teaching Musical Informatics*.
- Topic 8. *Software for Professional Activities of the Musician.*
- Topic 9. *Online Services to Help a Music Teacher*.

The curriculum of the discipline “Music Informatics” is presented in more detail in our works (see, for example [10-14]).

When forming the thematic content of the “Musical Informatics” discipline, the following professional activities of music teachers, and set certain tasks were taken into account:

- increase interest in the use of MCT and electronic musical synthesizer (EMS);
- increase the competency (according to professional standards), focus on the formation of its own digital learning environment using MCT and EMS, focusing on self-education, as the main element of professional development and overcoming the formalism of knowledge in the field of musical informatics.

In the process of research, a range of problems was identified, which makes it difficult to introduce and use digital means and resources in modern musical education, namely, the formalism of knowledge in the field of musical informatics.

Let's take a closer look at one of the sections of the courseю

Topic 1. THE SUBJECT OF MUSICAL INFORMATICS

As the name implies, computer science is the science of information. Obviously, first you need to understand what information is. There are many definitions, for example,

information is data given to us in sensations, etc. As we can see, here the concept of information is simply replaced by another one, which is also not defined (see *Fig. 1. Unknown information*).

Intuitively, we understand what information is, but we need a precise definition that can be used, for example, to measure its quantity. Such a definition is a mathematical definition.

Information is the removal of uncertainty on a known set of values (see *Fig. 2. Uncertainty and multiple values*).

Suppose we have some closed system that can be in several states, but we don't know what state it is in now. After receiving the information, we know more about the state of the system than we knew before. This is the information that distinguishes an unmeasured system from a measured one. So, information is the removal of uncertainty (i.e., reducing the number of variants of reality) on a predetermined set of values.

The system is anything, for example, a box of colored pencils. Closed – this means that nothing can change its state while we are doing it, measuring it (see *Fig. 3. Closed system*).

Suppose we say: "Red" means nothing to you. But if we say that we are talking about a box of pencils and that we choose one pencil, and there are only eight in the box, then we have removed the uncertainty by choosing one pencil out of eight (see *Fig. 4. Multiple values*).

If there were a hundred pencils in the box, then by saying "red" we would add information, removing a lot of uncertainty (see *Fig. 5. Removing uncertainty*).

If you expected us to just say a word, then by saying "red" we chose one word from a variety of words in the Russian language, and add a lot of information, removing a lot of uncertainty.

How to measure information? To begin with, we need to find the smallest piece of information as a standard with which we will measure large fragments. So the least amount of information is an unambiguous answer to the question YES or NO. It was called the BIT.

In mathematics, YES is denoted by the number 1, and NO is denoted by the number 0.

How to use a bit to measure more or less information? Just by asking questions and answering them YES or NO. Suppose that we have guessed a number in the range from 1 to 8, and you ask questions, and our answer is: YES or NO (see *Fig. 6. Example of measuring information, removing uncertainty*).

You can just sort through all the numbers by asking 8 questions, but you can guess using fewer questions, each time splitting the set roughly in half and asking which half is the intended number (why in half? because there are only two answers: YES or NO) (see *Fig. 7. Removing uncertainty, question No. 1, Fig. 8. Removing uncertainty, question No. 2, Fig. 9. Removing uncertainty, question No. 3*).

By splitting a set of 8 states in an optimal way (i. e. in half), you can find out its state in just 3 questions, thus, in a set of 8 unknown states there are only 3 bits of information, 011 = 3 bits.

And if there are 7 states, there are also 3 bits, just when splitting in half, it will not always be possible to divide the set exactly in half. The same is true for 6 and 5 elements, but in the set of 4 states there are already 2 bits of information (see Fig. *10. Removing uncertainty from 4 values*).

Note that with each answer, the number of possible states of the system is halved. Thus, the number of states of the system is two to the power of N, where N is the number of bits.

Try to evaluate in practice the amount of information in various sets (see Fig. *11. The amount of information in various sets*).

We have already estimated the amount of information in one word of a language. And if the language is unknown to us, but the number of letters in the language is known, then more information will be needed to determine the word (suppose a word of 5 letters N*N*N*N*N= 32*32*32*32*32 = 33 554 432 this is more than the maximum amount (100,000) words in the language) (see *Fig. 12. The amount of information in a word and in the number of letters of that word*).

And how to estimate the amount of information, even if the letters are unknown to us, for example, these are hieroglyphs of the Egyptian language, which are unknown to us. We will consider them as pictures. Let's divide the grid image into the minimum number of dots and write 1 if there is ink in the cell, and 0 if not (see *Fig. 13. Determining the amount of information in an unknown hieroglyph*).

If the image is colored, then we will make a separate grid for each color. It is clear that for such a description of the Egyptian inscription, we will need a very large amount of information that would take a very long time to process manually. Computer technology comes to our aid, which can operate numbers very well and quickly.

A computer can quickly analyze a large number of images, find similar ones, and, as a result, decipher an unknown script (see *Fig. 14. The computer can analyze any information*).

You can record any information in the form of numbers: images, sounds, molecules, etc. – this process is called digitization. Digitization makes it possible to apply mathematical methods of processing the data obtained in this way to the obtained numbers, which are easily "executed" by computers. This approach has been called information technology.

At the very beginning, the word "data" was mentioned. What is its difference from the concept of "information"? If we have a large number of numbers obtained as a result, for example, of digitizing something unknown, this is undoubtedly information, but not yet data. If the information is structured, typed (i.e. it is known, for example, that these numbers are an image, and these are sound, and the sound, for example, is stereo and the playback speed is indicated) and it is known by what means these numbers should be processed (sound is played by such a player, images are opened using the "graphic editor" application), then this is - data.

IV. Conclusion

A lot of events take place using remote forms - these are

online competitions, forums, festivals, teacher training, etc. The situation forces the teacher-musician to know modern digital technologies and techniques for organizing distance learning using various methods of network interaction. When applying a digital educational environment, the content of participants of network interaction is formed, which is aimed at obtaining new knowledge, skills and skills using MCT, EMS.

Thanks to the use of the developed pedagogic model [15-18], it was also possible to study a number of psychological and pedagogical features of the development of information technologies and MCT by people with deep visual impairments [19-21].

Classical musical education can be effectively supplemented with digital instruments and modern techniques that help realize musical education. Contemporary musicians need knowledge in the field of musical informatics in order to be competitive in modern conditions, to be able to work with musical information (record, process, save, present musical material using digital means). Music teachers need not formal knowledge in the field of digital technologies, but knowledge that can bring the teaching of musical disciplines to a new, modern level with the active use of digital technologies.

The authors consider it their duty to pay tribute to Alexander Vitalievich Haruto, whose works made a significant contribution to the development of this discipline "Music Informatics" and influenced a number of provisions of our textbook. The authors also rely on the works of Yuri Nikolaevich Rags, whose ideas, speeches and publications contributed to the formation of the subject under consideration in the musical and educational process.

Concluding the article, we note that the part of research in the field of musical informatics, which initially seemed to be purely theoretical in nature, finds application today in the practice of musicological research and work in the field of musical sound engineering and computer modeling of the process of musical creativity: E. O. Zelenina "Visualization of Spatial-Auditory Representations in the Process of Musical Education: Graphic Modeling Technologies" (2010); E. N. Bazhukova "Music Computer. Educational Program for Institutions of Additional Education of Children" (2010); I. B. Gorbunova, M. S. Zalivadny, E. V. Kibitkina "Musical Programming" (2012); S. V. Chibirev "Algorithmic Model of the Process of Composing Musical Fragments in MIDI Format": patent for invention (certificate of registration No. 2013611069 dated 9.01 2013); I. B. Gorbunova, M. S. Zalivadny "Information Technologies in Music. Volume 4: Music, Mathematics, Computer Science" (2013); "A Complex Model of the Semantic Space of Music" (2016), I. B. Gorbunova, M. S. Zalivadny, S. V. Chibirev "Music, Mathematics, Computer Science: Logical-Aesthetic and Technological Aspects of Interaction" (2017); M. B. Ignatiev, A. I. Makin "Linguistic-Combinatorial Modeling of Music" (2019), G. G. Belov, I. B. Gorbunova, M. I. Karpets "Musical Sound Engineering. Vol. 1: Fundamentals of Studio Sound Engineering" (2020), I. B. Gorbunova, K. B. Davletova, S. V. Mezentseva "Musical Instruments of the Digital Age" (2021), I. B. Gorbunova, S. V. Mezentseva, I. O. Tovpich, N. A. Yakentkovskaya "Music Computer Technologies in Teaching Musicians Computer Science at the Digital Age School" (2022), Gorbunova I., Chibirev S., Zalivadny M., Tovpich I. "Music, Mathematics, Computer Science: a Complex Model of the Semantic Space of Music" (2023), I. B. Gorbunova "Information Technologies in Music. Book 1: Architectonics of Musical Sound" (2022), N. A. Berger, I. B. Gorbunova, N. A. Yatsenkovskaya "Voice and Computer" (2023), G. G. Belov, I. B. Gorbunova, Lukash D. N., Yasinskaya O. L. "Musical Sound Engineering. Vol. 2: Instrumentation" (2023), I. B. Gorbunova, A. A. Pankova "Teaching Computer Science to Students of Music and Pedagogical Specialties" (2023), M. V. Mickiewicz "Music Computer Composition" (2023), I. B. Gorbunova "Information Technologies in Music. Book 2: Musical Synthesizers" (2023) and others.

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More than 15 years – lector in Music Computer Technologies;

More than 10 years in mobile applications development; team leader and software architect; currently working on mobile application for Android that implements the music creation model.

Main publications: Gorbunova I., Chibirev S. *Music Computer Technologies: On the Problem of Modeling the Process of Musical Creativity*: monograph. St. Petersburg: Publishing House of the Herzen State Pedagogical University of Russia, 2012; Gorbunova I., Chibirev S. *Computer Modeling of the Process of Musical Creativity*. Proceedings of the Herzen State Pedagogical University of Russia, 2014, no. 168, pp. 84-93; Gorbunova I., Chibirev S., Zalivadny M.. *Music, Mathematics, and Computer Science: Logical, Aesthetic, and Technological Aspects of Interaction*: monograph. St. Petersburg: Publishing House of the Herzen State Pedagogical University of Russia, 2017; Bazhukova E., Gorbunova I., Zalivadny M.S., Chibirev S. *Musical Informatics*: textbook. St. Petersburg: Publ. House Lan; Planet of Music, 2023; Gorbunova I.B., Chibirev S.V. *Modeling the Process of Musical Creativity in Musical Instrument Digital Interface Format*. Opcion. 2019. Vol. 35. No. S22, pp. 392-409; Gorbunova I., Chibirev S., Zalivadny M., Tovpich I. *Music, Mathematics, and Computer Science:* The *Integrative Model for the Semantic Space of Music*: monograph. St. Petersburg : Publ. House Planet of Music, 2023.

He has designed the Bachelor’s degree program "Music Computer Technology" and the Master’s degree program "Music Computer Technology in Education" accredited by the Ministry of Education of the Russian Federation. He has designed professional development and retraining programs for music teachers, including “Musical Informatics”, “Information Technology in Music and Musical Education”, etc.

Since 2002, Sergey V. Chibirev has been participating in the annual International Research and Practical Conference *Contemporary Musical Education: Creativity, Research, Technology* organized by the Education and Methods Laboratory *Music Computer Technologies* of the Herzen State Pedagogical University of Russia and the St. Petersburg State Conservatory named after N. A. Rimsky-Korsakov. His articles have been published in various scientific journals and editions.

Irina B. Gorbunova was born in Saint Petersburg (Leningrad), Russia. DipMus, Special Music Higher School of the St. Petersburg State Conservatory named after N.A. Rimsky-Korsakov; BSc in Computer Science: Information Technology, Computer Science and Multimedia, Leningrad State University, Ussurisk State Pedagogical University; MA in Education, the Herzen State Pedagogical University of Russia; PhD in Information Technology and Pedagogical Sciences, the Herzen State Pedagogical University of Russia, St. Petersburg, 1989; Doctor degree: Doctor of Pedagogical Sciences and Information Technology, the Herzen State Pedagogical University of Russia, St. Petersburg, 1999. Dr., Full Professor, Chief Researcher of the Education and Methods Laboratory *Music Computer Technologies* at the Herzen State Pedagogical University of Russia, St. Petersburg; hold the degree of Honorary Worker of Higher Professional Education of the Russian Federation.

Work experience:

1990 – 2010 - Associate Prof., Professor of the Department of Information Technology of the Herzen State Pedagogical University of Russia, St. Petersburg;

2010 - present - Full University Professor, Department of Information Technology, Institute of Computer Science and Technological Education at the Herzen State Pedagogical University of Russia, St. Petersburg;

2002 – present - Chief Researcher of the Education and Methods Laboratory *Music Computer Technologies* of the Herzen State Pedagogical University of Russia, St. Petersburg.

She has more than 300 scientific publications, among them are monographs *Music Computer Technologies: Historical-Theoretical and Practical Aspects*, St. Petersburg: Publ. House “SMIO Press” (2007.) and *Music Computer Technologies: The Problem of Modeling the Process of Musical Creativity*, compiled with participation of S. V. Chibirev, St. Petersburg: Publ. House of the Herzen State Pedagogical University of Russia (2012); textbook *Information Technology in Music*, vol. 1 – 4: vol. 1, *Architectonics of Musical Sound* (2009), vol. 2, *Musical Synthesizers*, 2010; vol. 3, *Musical Computer*, 2011; *Music, Mathematics and Computer Science*, vol. 4, 2013, St. Petersburg: Publ. House of the Herzen State Pedagogical University of Russia; Bazhukova E., Gorbunova I., Zalivadny M.S., Chibirev S. *Musical Informatics*: textbook. St. Petersburg: Publ. House Lan; Planet of Music, 2023; I. B. Gorbunova "Information Technologies in Music. Book 1: Architectonics of Musical Sound" Moscow: Publ. House URSS, Lenand (2023); I. B. Gorbunova "Information Technologies in Music. Book 2: Musical Synthesizers". Moscow: Publ. House URSS, Lenand (2023).

Prof. Dr. Gorbunova is a Chairperson of the annual Iinternational Research and Practical Conference *Contemporary Musical Education* held since 2002; Chairperson of the annual International Research and Practical Conference *Music Computer Technologies in the System of Contemporary Education* held since 2007.

Dr. Gorbunova is a member of the Jury of national and international competitions of musical creative works, including *Electronic Palette* (Saint-Petersburg), *Music and Electronics* (Moscow), *Music of the 21st Century* (Moscow / Saint-Petersburg), International Festivals and Competitions *Musical Electronics and Multimedia* (Moscow / Saint-Petersburg), *CLARINE of the 21st Century* (Saint-Petersburg), *The World of Art without Borders* (Saint-Petersburg, Russia - Szeged, Hungary), *Bridge of Friendship* (Dortmund, Germany), All-Russian Competition of Electroacoustic Music *DEMO* (Saint-Petersburg).

Prof. Dr. Gorbunova has developed first ever course in Music, called “Music Computer Technologies”, which has been offered under the Bachelors of Arts and Sciences (BASc), and she also leads post-graduate course "Music Computer Technologies in Education" available under the MA in Music Education.

Prof. Dr. Gorbunova supervises a number of doctoral and post-doctoral students (more than 30) and lectures on Music Computer Technologies and Information Technology in Music. She supervises research in various directions, among them there are: Theory and History of Culture, Music Art, Information System and Processes, Theory and Methodology of Professional Education, Mathematical Modelling, Numerical Methods and Program Ssystems, Theory and Methods of Education and Upbringing (in Music, Informatics, natural sciences). The research results of Prof. Gorbunova were published in over 500 refereed publications including 49 books and more than 300 papers in various scientific journals.

Her research activities include such directions as: MCT in professional music education (as a means to expand creative opportunities); MCT in general musical education (as one of the means of education); MCT as a means of rehabilitation of people with disabilities; MCT as the new direction in preparation of specialists of humanitarian and technological profile; MCT in the field of digital arts; MCT in information technology, psychoacoustics and musical acoustics; system of training arrangements and the art of performing skills on electronic musical instruments. Her circle of interests also includes the problems of interrelation of natural and technical sciences and humanities, as well as the possibilities of applying the results of such interrelation for the purposes of music education and upbringing. She also takes part in working out the specialized software for computer music devices and in application of this software in pedagogical processes. Her developments and researches also belong to the field of musical pedagogics and musicology, musical informatics, computer modeling of processes of musical creativity, timbre programming, art of performing skills and arrangement on electronic musical instruments, creative work in the field of computer music, mathematical methods in musicology.

Andreas Kameris

Andreas Kameris was born in Nicosia, Cyprus.

2001 - Master of Musical Arts (composition) – St. Petersburg State Conservatory named after N. A. Rimsky-Korsakov;

2005 - Doctor of Musical Arts – St. Petersburg State Conservatory named after N.A. Rimsky-Korsakov;

2007 - PhD in History of Arts, Herzen State Pedagogical University of Russia, St. Petersburg.

Work experience:

2001 – 2003 - Lector at St. Petersburg Bershadsky Private Conservatory 2002 – present - Research Scientist and Lector at the Education and Methods Laboratory *Music Computer Technologies*, Herzen State Pedagogical University of Russia

2005 – 2012 - Visiting Lector at ARTE Music Academy, Nicosia, Cyprus.

Main publications:

Gorbunova I., Kameris A. *The Concept of Music Computer Education in Preparing the Teacher-Musician*: monograph. St. Petersburg: Publishing House of the Herzen State Pedagogical University of Russia, 2011; Belychenko V., Gorbunova I., Kameris A. *Music Computer Technologies in the Preparation of a Music Teacher*. St. Petersburg: Herzen University Press, 2011; Belychenko V., Bryantsev M., Gorbunova I., Kameris A., Kibitkina E. *Development of the Information Competency of a Modern musician based on Music Computer Technologies*. St. Petersburg: Herzen University Press, 2012.

Andreas Kameris’s compositions for symphony orchestra, small musical ensembles and chorus have been performed at various concerts and festivals. He has designed the Bachelor’s degree program "Music Computer Technology" and the Master’s degree program "Music Computer Technologies in Education" accredited by the Ministry of Education of the Russian Federation.

Since 2002, Andreas Kameris has been participating in the annual International Research and Practical Conference *Contemporary Musical Education* organized by the Education and Methods Laboratory *Music Computer Technologies: Creativity, Research, Technology* of the Herzen State Pedagogical University of Russia and the St. Petersburg State Conservatory after N. A. Rimsky-Korsakov.

His articles have been published in various scientific journals and editions.

He is a member of the jury of the All-Russian Competition *Musical Palette* held each year in St. Petersburg; *The World of Art without Borders: Bridge of Friendship* (Saint-Petersburg, Russia - Szeged, Hungary – Baku, Azerbaijan - Nicosia, Cyprus), the All-Russian Competition *CLARINE of the 21st Century* held twice a year from 2017 in St. Petersburg.