ANDRZEJ MĄDRO

MUSIC AND NEW MEDIA

POLISH ELECTROACOUSTIC ART AT THE TURN OF THE 20TH AND 21ST CENTURIES

PENDERECKI ACADEMY PRESS

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Introduction

The word 'media' owes its presence in the cultural discourse chiefly to Marshall McLuhan, a pioneer of modern media studies. His work, *Understanding Media*: *The Extensions of Man* (1964),[1] caused a seismic shift in how new communication technologies are understood and approached, both in relation to pop culture and art. With the advancement of electronics, both the conceptual range of the term 'media' and media in itself have undergone pivotal changes.[2] By virtue of the above, the term 'new media' was coined at the end of the 20th century in order to distinguish between 'old', which is to say, analogue, and 'new', digital technologies. It turns out, however, that in our day and age this concept too is not a clear-cut one at all, especially given that analogue and digital technologies coexist and freely intermingle, forming ever newer, integral configurations.

In the present work, the term 'new media' is used in the broadest sense possible, as defined by Ryszard Kluszczyński, i.e. 'technical means, as well as related processes and specific materials that are

1 Marshall McLuhan, *Understanding Media: The Extensions of Man* (New York: McGraw Hill, 1964) (Polish translation: *Zrozumieć media. Przedłużenia człowieka*, translated by Natalia Szczucka, Warszawa: Wydawnictwa Naukowo-Techniczne, 2004).

2 In German media studies, it is common to classify media according to a four-degree scale. It distinguishes the following kinds of media: 'human' or 'first-degree' media, which is to say media which, at every stage of the communication process – that is, production, transmission, and reception – only employ the dispositions of man and his senses; second-degree media, where the production and transmission process is assisted by technical means (such as print, photography, or phonography); third-degree media, where technology is present at every stage of communication; and fourth-degree media, based on digital, convergent computer technologies integrating the process of communication. See: Łukasz Guzek, *Sztuka instalacji. Zagadnienie związku przestrzeni i obecności w sztuce współczesnej [Installation Art. The Issue of the Relationship between Space and Presence in Contemporary Art]* (Warszawa: Neriton, 2007), p. 51.

developed in the act of creation – not directly, but only through the said mediatising technical means'.[3] Thus, any electroacoustic creation may be deemed to be new media music.

The different types of new media have changed the world of art, including music, in almost every field and aspect. Electronics based on analogue, and, later, digital technologies revolutionised the ways of composing, writing, recording, performing, listening to and distributing music. This 'epochal' phenomenon, posit the authors of New Media: A Critical Introduction, has become part of a 'part of a larger, even global, historical change', notwithstanding whether it is regarded as a cause or a product thereof.[4] This fact, however, is very much absent from the Polish musicological debate. As such, the main objective of the present work is to initiate theoretical research of the presence of new sound media in art and the issues surrounding them, with a particular focus on the most vibrant of musical currents today: electroacoustic music. This sphere of art was able to come into being owing to new technologies, and evolved alongside them. Over time, it assimilated a number of characteristics of new media art, simultaneously exhibiting strong tendencies to transcend the sonic dimension.[5] The term 'sound art' emerged for a reason. In addition to electroacoustic works, it included a range of forms and phenomena that were new additions to art, including live electronics, performances, installations, as well as acoustic ecology. When it comes to music theory, there is still no comprehensive conceptualisation on this subject. Meanwhile, new media are becoming ever more ubiquitous, as the entirety of modern culture is becoming media-based. The present work, therefore, aims to make a preliminary identification of the techno-aesthetic areas of sound art – 'new media music' – and to make an attempt at capturing the most important characteristics of the works created within the framework thereof, aspiring to be the art of the future.

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3 Ryszard W. Kluszczyński, *Sztuka interaktywna. Od dzieła-instrumentu do interaktywnego spektaklu [Interactive Art According to Ryszard Kluszczyński]* (Warszawa: Wydawnictwa Akademickie i Profesjonalne, 2010), p. 15.

4 Martin Lister, Jon Dovey, Seth Giddings, Iain Grant, and Kieran Kelly, *Nowe media. Wprowadzenie [New Media. A Critical Introduction]*, translated by Marta Lorek, Agata Sadza, Katarzyna Sawicka (Kraków: Wydawnictwo Uniwersytetu Jagiellońskiego, 2009), p. 17.

5 When it comes to media art, certain paradoxical situations arise: visual artists may produce artefacts that are to a certain degree sonic, while composers utilise visual means of expression.

The manner of presentation of the subject matter entails outlining historical developments in relation to any and all sound media, discussing the most important currents, genres, techniques, as well as works representative of them, with particular emphasis being placed on Polish composers. The present work also aims to clarify the concepts that are of fundamental importance to the subject matter and adapt them to suit the musicological debate. Not unlike computer science, the field of electroacoustics is filled with a plethora of diverse jargon terms and terms of foreign origin which, with no Polish equivalents found, have become permanently associated with this field.

For the popularity of Polish electroacoustic art, the number of publications dedicated to it may strike one as surprisingly small. For music theory, the subject matter in question, despite having existed for over half a century, is still new, though an important one that demands to be investigated. The available sources of information on Polish electroacoustic art are either outdated,[6] overly brief,[7] and selective,[8] or discuss the matter from a purely technical angle.[9] The bulk of the information on important artistic works and projects – pieces, installations, and performances – only comes from interviews, self-interpretations and commentaries by composers, concert and festival reviews or websites. These publications are mostly journalistic in nature, while broader,[10] strictly scientific studies are lacking.

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6 *Horyzonty muzyki [Horizons of Music]*, ed. Józef Patkowski, Anna Skrzyńska (Kraków: Polskie Wydawnictwo Muzyczne, 1970); *Forum Musicum* 1966–1967; 1972–1974; Włodzimierz Kotoński, *Muzyka elektroniczna [Electronic Music]* (Kraków: Polskie Wydawnictwo Muzyczne, 1989), 1st edition.

7 Mieczysław Kominek, *Muzyka elektroakustyczna w Polsce [Electroacoustic Music in Poland]*, http://culture.pl/pl/artykul/ muzyka-elektroakustyczna-wolsce; Marek Zwyrzykowski, *Początki muzyki elektroakustycznej w Polsce [Beginnings of Electroacoustic Music in Poland]*, *Glissando*, 2005, issue 4, p. 42.

8 Marek Chołoniewski, *Multimedia* [in:] *Kompozytorzy polscy 1918–2000. Praca zbiorowa [Polish Composers in Years 1918–2000. A Collective Work]* Vol. 1: *Eseje [Essays]*, ed. Marek Podhajski, (Gdańsk—Warszawa: Wydawnictwo Akademii Muzycznej im. S. Moniuszki, 2005); *Orfeo ed Elettrice. Szkice o muzyce elektronicznej [Orfeo ed Elettrice. Sketches on Electronic Music]*, ed. Paweł Krzaczkowski, Sławomir Wieczorek (Wrocław: Chiazm, 2008).

9 William von Mobius, *Magia sygnału: cyfrowa elektroakustyka [The Magic of Signal: Digital Electroacoustics]* (Gliwice: Helion, 1996); Andrzej Czyżewski, *Dźwięk cyfrowy: wybrane zagadnienia teoretyczne, technologia, zastosowania [Digital Sound: Selected Theoretical Issues, Technology, Applications]* (Warszawa: Exit, 1998); Jan Oleszkowicz, *Muzyka – elektronika – informatyka [Music – Electronics – Informatics]* (Warszawa: Centrum Edukacji Artystycznej, 2010).

10 *Glissando*; *Meakultura*; *Co w duszy gra – blog by Dorota Szwarcman*; *Dwutygodnik*.

Compared to other fields – plastic and visual arts (visual studies),[11] theatre and performative arts (performance studies),[12] cinema,[13] media studies[14] and, last but not least, aesthetics[15] – research on Polish contemporary music related to new media remains neglected. The research described within the English-language literature, which boasts a number of highly-specialised works, looks much better. It

11 Konrad Chmielecki, *Estetyka mediów wizualnych i studia nad kulturą wizualną (Visual Culture Studies): nowe obszary refleksji nad sztuką [The Aesthetics of Visual Media and Visual Culture Studies: New Areas of Reflection upon Art],* https://www.academia.edu/3840319/Esthetics_media_visual_and_Visual_Culture_Studies.

12 Richard Schechner, *Performatyka: wstęp [Performance Studies: An Introduction],* translated by Tomasz Kubikowski (Wrocław: Centre for Study of Jerzy Grotowski's Work and of Cultural and Theatrical Research, 2006); Marvin A. Carlson, *Performans* [*Performance: A Critical Introduction]*, translated by Edyta Kubikowska, scientific editor of the Polish edition: Tomasz Kubikowski (Warszawa: Wydawnictwo Naukowe PWN, 2007); Erika Fischer-Lichte, *Estetyka performatywności [The Transformative Power of Performance: A New Aesthetics]*, translated by Mateusz Borowski, Małgorzata Sugiera (Kraków: Księgarnia Akademicka, 2008); *Zwrot performatywny w estetyce [The Performative Turn in Aesthetics]*, ed. Lilianna Bieszczad (Kraków: Libron, 2013).

13 Andrzej Gwóźdź, *Obrazy i rzeczy. Film między mediami [Images and Things. Film between Media]* (Kraków: Universitas, 2003); *Pogranicza audiowizualności [The Peripheries of Audiovisuality]*, ed. Andrzej Gwóźdź (Kraków: Universitas, 2010); Kluszczyński, *Film-wideo-multimedia: sztuka ruchomego obrazu w erze elektronicznej [Film-Video-Multimedia: the Art of the Moving Image in the Electronic Age]* (Kraków: Rabid, 2002).

14 Dieter Mersch, *Teorie mediów [Media Theories]* (Warszawa: Wydawnictwo Sic!, 2010); Edwin Bendyk, Mirosław Filiciak et al., *Kultura 2.0. Wyzwania cyfrowej przyszłości [Culture 2.0. Challenges of the Digital Future]* (Warszawa: Polskie Wydawnictwo Audiowizualne, 2007).

15 *Piękno w sieci. Estetyka a nowe media [Beauty on the Web. Aesthetics and New Media]*, ed. Krystyna Wilkoszewska (Kraków: Universitas, 1999); Michał Ostrowicki, *Wirtualne 'realis': estetyka w epoce elektroniki [Virtual 'Realis': Aesthetics in the Age of Electronics]* (Kraków: Universitas, 2006); Salomé Voegelin, *Listening to Noise and Silence: Towards a Philosophy of Sound Art* (New York et al.: Continuum, 2010; Wolfgang Welsch, *Estetyka poza estetyką. O nową postać estetyki [Aesthetics beyond Aesthetics. Towards a New Form of the Discipline]*, ed. Krystyna Wilkoszewska, translated by Katarzyna Guczalska (Kraków: Universitas 2005); Iman Moradi, *Glitch Aesthetics* (The University of Huddersfield, 2004); Torben Sangild, *The Aesthetics of Noise* (København: Datanom, 2002); Roman Bromboszcz, *Estetyka zakłóceń [The Aesthetics of Interference]* (Poznań: Wydawnictwo Naukowe Wyższej Szkoły Nauk Humanistycznych i Dziennikarstwa, 2010); Konrad Chmielecki, *Estetyka intemedialności [The Aesthetics of Intermediality*] (Kraków: Rabid, 2008).

includes book publications, journals,[16] and individual articles, not uncommonly created within the framework of the activities and research projects of the world's leading electroacoustic music centres.[17]

This work is structured so as to present the subject matter from a historical perspective (part one), a techno-aesthetic one (part two) and one of exemplification and interpretation (part three).

Part one recounts the development of all sonic and musical media in as broad a historical perspective as possible (chapter 1.1), with particular emphasis on the new instruments – electrophones (1.2), as well as musical genres and currents (1.3, 1.4, 1.5), where the nodal points of development are the pioneering achievements of the composers. The structure of this part aims to systematise and classify the issues and examples discussed, which, in turn, has an impact on the order of the final portion of the work.

Part two of the work constitutes an attempt to situate the research within the context of the most important technological and aesthetic issues, first and foremost, the key features of new media: multimediality, interactivity and virtuality (2.1), then issues closer to music itself: sonic character (2.2), spatiality (2.3), and a certain kind of transmedial perception (2.4). These issues are shown against the background of changes in art and music and supported by representative examples.

At the dawn of the new millennium, Polish electroacoustic art became an area so vast that it is nigh on impossible to cover comprehensively. Thus, part three examines selected, representative works by Stanisław Krupowicz, Magdalena Długosz, Cezary Duchnowski, Krzysztof Knittel and Marek Chołoniewski. Although the work and artistic activity of these composers constitute important contributions to the development of electroacoustic music – after all, they have received awards and are appreciated by art critics and academia alike – no broader studies have been devoted to this music as of yet. Another important criterion for this specific selection was the fact that the mindsets of the said composers represent different approaches to new media, different strategies, and original compositional techniques, which in turn permits a broad coverage of the subject. The

16 *Computer Music Journal*, http://www.mitpressjournals.org/cmj; *Organised Sound*, http://journals.cambridge.org/action/displayJournal?jid=OSO.

17 IRCAM – Institut de Recherche et Coordination Acoustique/Musique, http://www.ircam.fr/recherche.html?L=1; CCRMA – Center for Computer Research in Music and Acoustics, https://ccrma.stanford.edu/papers.

results of the analyses and interpretations carried out form the basis for a synthetic coverage of the constitutive features of works by the selected composers.

New musical media have given artists hitherto-unseen means of artistic expression, opening up new and unexplored areas of aesthetics. Piotr Celiński noted the following:

> Media objects and media artworks turned out to have an immaterial consistency, a different physical state which did not fit in the previously-known canon of forms and matter of artistic expression. Thus, art, or, more broadly, culture, have found their way inside the media – they have been mediatised, absorbed by the rules and grammars thereof.[18]

Traditional musical interpretation is based on the immutability of the work being examined, as well as on the permanence and repetitiveness of experiencing it. At the same time, the ontological status of a piece-project, which may sometimes assume the form of an improvisation, at other times of an interactive installation, and at yet other times of an online transmission or other innovative forms, changes radically.[19] Thus, when it comes to electroacoustic works, many of the categorisations, methods of analysis and interpretation or aesthetic paradigms developed by music theory (which one would have been inclined to deem universal or timeless) need to be reconsidered and expanded.[20] A need – a necessity, even – persists to develop a new music theory with an interdisciplinary orientation: sound studies.[21]

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18 Piotr Celiński, *Postmedia. Cyfrowy kod i bazy danych [Postmedia. Digital Code and Databases]* (Lublin: Wydawnictwo Uniwersytetu Marii Curie-Skłodowskiej, 2013), p. 22.

19 It is difficult to examine interactive projects that only exist during the communication process and are coterminous therewith. 'The activation of hypertext as a new communicative process, even by the same viewer, brings a new creation into being. Both the analysis and the interpretation of a work thus construed must be parallel to the process of its reception – its (co-) creation. They must be coterminous. Reception, creation, analysis, and interpretation become one and the same process of creative communication.' Kluszczyński, *Internet – nowe terytorium ekspresji [Internet – a New Territory of Expression]*, http://csw.art.pl/warsztaty/rwk_p.html.

20 Krzysztof Knittel wrote: 'One may say what they will about analytical and theoretical systems, but, if one is to analyse new music, it has to be the starting point. If we try and analyse it by old means, something is always going to end up amiss.' *Krzysztof Knittel – interview* by Dorota Szwarcman, *Ruch Muzyczny* (1978), issue 5, pp. 4–6.

21 See: http://www.soundstudies.eu/.

As Espen Aarseth says, 'traditional semiotic models and terminology, which were developed for objects that are mostly static, [become] useless in their present, unmodified form.'[22] The conceptual nature of many works that are still at the work-in-progress stage means that it is not just the sonic and visual results of a given work-project that should be at the centre of interpretation, but also – and, in all likelihood, especially – the new media involved in their execution. The focus shifts from asking 'how does it sound?' to 'how does it work?'. Thus, the interpretation method should not merely 'start with' the work, but also adopt a media research perspective in line with the idea of the present work. It appears necessary to adapt to the musical context the language and theory of communication, mass media theory, electro- and psychoacoustics, as well as concepts developed in the field of visual arts, theatre and media art as understood in the broadest sense.

In order to be able to fully answer the questions as to what a work is made of and how it is made, as well as to make interpretations of electroacoustic projects, one must be familiar with the compositional tools involved in the process: computer programming, the manner in which samplers, synthesizers and multimedia work, as well as their possibilities. Indeed, the electroacoustic studio based on computer systems has become the basis of the modern composer's work. For a researcher, knowing such environments is now a must.

When it comes to electroacoustic works, especially 'tape' music, valuable analytical results are offered by spectral analysis (time spectrograms). This is especially true because, provided that one employs appropriate software, analysis may be carried out both at the level of individual sounds (frequency spectrum, filtering of selected frequency areas) and that of the entire musical work (spectrograms, amplitude-time diagrams).[23] Such methods are particularly helpful when the auditory impressions significantly deviate from the content of the score or if a given work was not scored at all.

In the case of multimedia projects, installations and performances, it is necessary to adopt a broader research perspective. Krystyna Wilkoszewska argues that it is impossible to come up with

22 Espen J. Aarseth, *Cybertext: Perspectives on Ergodic Literature*, (Baltimore: Johns Hopkins University Press, 1997), p. 26

23 See: Curtis Roads, *The Computer Music Tutorial* (Cambridge: MIT Press, 1996), pp. 536–547.

one coherent aesthetic of new media,[24] thus going the methodological route necessitated referring to many different theories. When it comes to electroacoustic music, of value are those that change the optics of the researcher rooted in traditional aesthetics (sufficient when it comes to traditional art), by, for example, having them look at creation and the work of art as a process,[25] a spectacle,[26] or a virtual entity,[27] focusing on technology (techno-aesthetics, digital aesthetics[28]), communication,[29] perception (auditory scene theory),[30] the senses (aesthetics,[31] anaesthetics[32]) and experiences (neuroaesthetics[33]).

24 Krystyna Wilkoszewska, *Estetyka nowych mediów [Aesthetics of new media]* [in:] *Piękno w sieci… [Beauty on the web...]*, p. 9.

25 Bogusław Jasiński, *Estetyka po estetyce [Aesthetics after Aesthetics]* (Piaseczno: Ethos, 2008).

26 Fischer-Lichte, *Estetyka performatywności*...

27 *Estetyka wirtualności [The Aesthetics of Virtuality]*, ed. Michał Ostrowicki, (Kraków: Universitas, 2005); M. Ostrowicki, *Wirtualne „realis"*...

28 Jaron Lanier, *Jak muzyka zbawi duszę technologii [How Music Will Save the Soul of Technology]* [in:] *Media Art Biennale WRO 97*, eds. Piotr Krajewski and Violetta Kutlubasis-Krajewska (Wrocław: Open Studio, 1997).

29 Denis McQuail, *Teoria komunikowania masowego [McQuail's Mass Communication Theory]*, translated by Marta Bucholc, Alina Szulżycka (Warszawa: Wydawnictwo Naukowe PWN, 2007); Tomasz Goban-Klas, *Cywilizacja medialna [The Media Civilisation]* (Warszawa: Wydawnictwa Szkolne i Pedagogiczne, 2005); *Komunikowanie (się) w mediach elektronicznych. Język, edukacja, semiotyka. Monografia [Communicating in Electronic Media. Language, Education, Semiotics. A Monograph]*, eds. Mirosław Filiciak, Grzegorz Ptaszek (Warszawa: Wydawnictwa Akademickie i Profesjonalne, 2009).

30 Albert S. Bregman, *Auditory Scene Analysis: The Perceptual Organization of Sound* (Cambridge: The MIT Press, 1994).

31 Agnieszka Bandura, *Aisthesis. Zmysłowość i racjonalność w estetyce tradycyjnej i współczesnej [Sensuality and Rationality in Traditional and Contemporary Aesthetics]* (Kraków: Universitas, 2013); Teresa Pękala, *Dyskurs estetyczny – rekapitulacje i prognozy [The Aesthetics Debate – Recapitulations and Prognoses]*, *Diametros*, 2005, issue 3, p. 121.

32 Wolfgang Welsch, *Estetyka i anestetyka [Aesthetics and Anaesthetics]* [in:] *Postmodernizm. Antologia przekładów [Postmodernism. An Anthology of Translations]*, ed. Ryszard Nycz (Kraków: Baran i Suszczyński, 1997); Odo Marquard, *Aestethica and anaestethica. Rozważania filozoficzne [Aestethica and Anaestethica. Philosophical Considerations]* (Warszawa: Oficyna Naukowa, 2007).

33 Włodzisław Duch, *Neurokognitywna teoria* świadomości. *Studia z kognitywistyki i filozofii umysłu [A Neurocognitive Theory of Consciousness. Studies in Cognitive Science and Philosophy of Mind]*. *I. Subiektywność a świadomość [I. Subjectivity and consciousness]*, ed. Wioletta Dziarnowska and Andrzej Klawiter, (Poznań: Zysk i S-ka, 2003), pp. 133–154; Duch, *Neuroestetyka i ewolucyjne podstawy przeżyć estetycznych [Neuroaesthetics and the Evolutionary Basis of Aesthetic Experiences]*, https://pdfs.semanticscholar.org/1255/3d3bc396fdd1405fd6614741c9f79eae6629.pdf.

The theoretical reflection on sound art is a kind of vivisection, as it concerns a field that is still vividly developing and evolving. Krzysztof Szwajgier points out that new media creations, 'spanning the diapason between the expression of ardent, polysensory sensuality and the rational calculation of technological embedding, make extraordinary demands on everyone interpreting them'.[34] It is necessary that the attitude of such an interpreter strike a balance between the technical and the aesthetic. This is because awareness of how technology works should not obfuscate the meanings created therewith.

34 Krzysztof Szwajgier, *Pułapka intermedialna [The Intermedia Trap]* [in:] *Interfejsy sztuki [The Interfaces of Art]*, ed. Antoni Porczak (Kraków: Wydawnictwo Akademii Sztuk Pięknych w Krakowie, Katedra Intermediów Wydziału Rzeźby, 2008), p. 137.

PART ONE

Introduction: from the triune chorea to sound art

1.1. Music and its media – a historical overview

The development of mass media has had a continuous impact on every aspect of social life, including the form of musical culture as well as the consciousness of artists. Indeed, the media have an impact not merely on the form of the information carried, but on its content as well. The study of music history, on the other hand, tended to place the creator and their work at the centre of its interest, sidelining all that was associated with recording, performance and dissemination, which is to say, musical media. And yet, it was they who shaped both the techniques of composition and performance, as well as the choice of the line-up and the sonic qualities, to a significant extent.

As pointed out by Krystyna Wilkoszewska:

> The two great aesthetics – mimetic and expressive – needed 'media', that is, sounds, colours, shapes or lines, as a kind of conduit, a bridge between art and the external world depicted or the internal world expressed. At the same time, the history of art shows how the means of expression used by artists have changed – hand in hand with general cultural changes – from era to era, and how, on the other hand, important changes to the 'media' employed (...) have marked successive stages of development of the history of our culture.[35]

Media have accompanied art from its very beginnings, and it would be challenging to discuss the development of artistic achievements without them. Granted, owing to people like Marshall McLuhan, research related to the history of old and new media was initiated in mid-20th century. However, these matters have become the domain of cultural and media scholars, much less so of music theorists. Moreover, the research focused on the matters of image and the visual, even if it involved audiovisual messages. However, the matters related to sound media still remain at the sidelines and thus there is a need, especially in Polish-language literature, to put the history of music in a media perspective, as well as to initiate the field of media musicology.

1.1.1. The first sound media – voice, song, and instruments

The original medium of music, construed in the broadest sense, was the human v o i c e – a natural source of all kinds of sounds. For ancient cultures, what mattered were not so much the aesthetic qualities of the sounds obtained with the voice as their ritual and

35 Wilkoszewska, *Estetyka nowych mediów* [in:] *Piękno w sieci…*, p. 8.

utilitarian role. Quickly enough, it became apparent that the whole body could act as an instrument – the sounds of clapping, stomping, and jumping constituted the first accompaniment to singing. Since the dawn of times, man has also sought other, 'artificial' means of sound. Archaeological research demonstrates that the first primitive i n s t r u m e n t s, such as pipes and flutes, appeared around 60 millennia ago. Jaques Barzun believes that it was even then that music came into contact with technology. In 1961, during his first concert at the Columbia-Princeton Electronic Music Center, he said:

> The moment man ceased to make music with his voice alone, the art became machine-ridden. Orpheus's lyre was a machine, a symphony orchestra is a regular factory for making artificial sounds, and a piano is the most appalling contrivance of levers and wires this side of the steam engine.[36]

Following this train of thought, the sounds of instruments should be considered artificially 'generated', and therefore a product of 'new' musical technologies.

'Endemic' instruments were developed by each cultural circle. Using Western culture as an example, it is easy to trace how dynamically their constructions have evolved in the eras that followed. One might even theorise that the increasing technical possibilities, availability, and popularity of instruments had a significant impact on the rhythm of these eras. In antiquity, vocal and instrumental means led the charge, though it remained fully dependent on poetry. The Middle Ages were dominated by vocal religious music (seeing as the voice was seen as the only 'divine' source of sound), but the number of instruments of all kinds grew and reached a climax in the Renaissance, the age of humanism and invention. Since then, performance techniques have been perfected and ensembles founded, culminating in the orchestra model – the most significant sound medium of classical music. Ever more present were instrumental works, rivalling the importance of vocal works in the Baroque era. During classicism, it gained a clear edge, fulfilling the idea of absolute music. Symphony, string quartet, suite and sonata, as well as concerto, the latter intended to give particular exposure to the possibilities of the solo instrument by design, were considered to be the most perfect of genres. The Romantic 'age of passion' set its sights on the

36 Jaques Barzun, quoted in: Gregory Battcock, *Breaking the Sound Barrier: a Critical Anthology of the New Music* (New York: Elsevier-Dutton Publishing Co., 1981), p. 200.

individualisation and hypertrophy of classical models. The means of making music were developed and the line-up was enlarged; thus, much like in the Baroque, music was dominated by monumental vocal and instrumental works. Conversely, the 20th century sought to prove by all means that the use of an instrument could far transcend traditional instrumentation. Experimentation with sound media became a marker of many new techniques of performance and musical trends (impressionism, sonorism, spectralism). Electrophones came to prominence as well, with their expansion, especially in popular music, outgrowing acoustic instrumentation over time. The impact of these new electronic media – not merely of instruments, at that – ushered in a new kind of music, but also marked a new era.

1.1.2. Music in Petrucci's 'galaxy' – print

Since the dawn of time, the primary medium of cultural communication was the voice; after all, until the invention of notation, music was passed on by oral means first and foremost,[37] from generation to generation, in master-student relationships. One must be aware of the limitations in this way of 'recording' for music.[38]

The first musical 'scores' preserved in the form of clay tablets with inscriptions containing instructions for the performer were based on Sumerian cuneiform script, dating back several thousand years. The history of proper musical notation, however, began with the history of the alphabet, i.e. with one character corresponding to one sound.[39] For

37 It was not until the 12th century that people started to acquire knowledge through reading in silence, on one's own. See: Christian Vandendorpe, *Od papirusu do hipertekstu. Esej o przemianach tekstu i lektury [From Papyrus to Hypertext: Toward the Universal Digital Library]*, translated by Anna Sawisz (Warszawa: Wydawnictwa Uniwersytetu Warszawskiego, 2008), p. 21.

38 The lack of use of precise musical notation manifested once again in the 19th century, when the music of African-American slaves was born from scratch – from 'cultural zero', almost. The craftsmanship of composition and notation were replaced by the richness and freedom of musical improvisation, paving the way for important and vital musical trends, such as blues and jazz.

39 This kind of alphabet was invented by the Phoenicians around 1000 BC. The ancient Greeks applied it to the notation of instrumental music; as far as vocal music was concerned, they had already been using the Greek alphabet (though this alphabet, too, was derived from Phoenician characters, as are most of the writing systems of Western and Middle Eastern civilisations). Some of the items preserved from the ancient times are texts carved in stone with musical symbols above them (two *Delphic Hymns* from the 2nd century BC, whence one may infer that diatonic scales were in use at the time), as well as plaques indicating the numbers and names of the strings, or the lyre tuning system. See: Anne D. Kilmer, Miguel Civil, *Old Babylonian Musical*

a long time, recording music in the form of notation was viewed with a certain dose of reserve. More commonly, what was written down were general, universal rules for creating and performing music. To the Greek theorists, it seemed far more important to perpetuate the principles of the sound system – the ancient Greek scales, the *systema teleion*, the Pythagorean tuning system – rather than its individual concretisations, that is pieces.

Print, one of the most important media in the history of mankind, has, as predicted, brought radical changes to every aspect of the world of music. Paweł Gancarczyk posits that this first mass medium 'played a crucial, if not the foremost role in the sequence of evolutions, upheavals and revolutions'.[40] While, as far as human contact goes, print has significantly disrupted the homogeneity of social structures and permitted the consolidation of centres of power, culture has undergone a process of homogenisation. Owing to the development of this medium, the barrier of distance was finally overcome, making it possible to freely exchange ideas and mix styles and techniques of physically-distant musical centres. While experiencing a given work was still only possible in the auditory dimension, contact with the subject had to take place in physical proximity, 'here' and 'now'. The advent of musical notation made it possible to separate the act of communication from the specific situation and its immediate context. Music could even be read 'silently'.

Ottaviano Petrucci (1466–1539), a pioneer of musical typography, may be deemed the Gutenberg of sheet music printing. His first publications appeared in 1501, less than half a century after the discoveries of Gutenberg himself. The nature of musical notation made the creation of scores much more complicated and time-consuming than printing text. Just as printing contributed to codifying the rules of grammar and the orthography of people's mother tongues and spreading literacy, in the field of music, too, the gradual shift away from manuscript practice forced the revision, simplification and standardisation of musical notation (in no small part due to economic considerations as well). As noted by McLuhan, a collateral effect of the popularisation of print was increasing the distance between the

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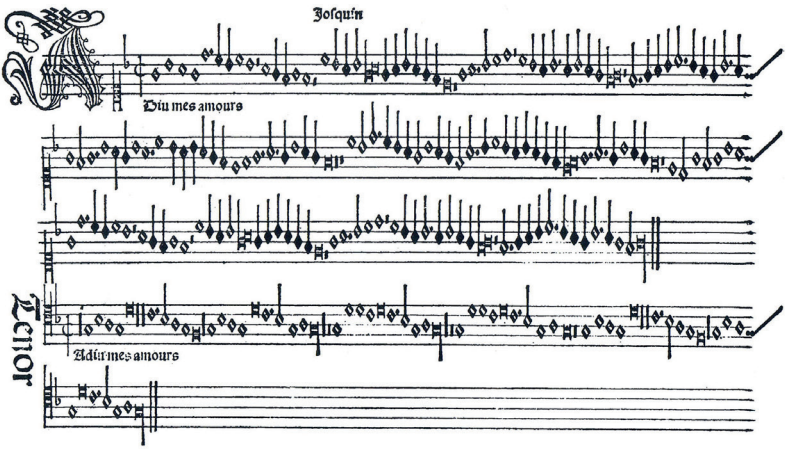
Instructions Relating to Hymnody, *Journal of Cuneiform Studies*, 1986, Vol. 38, issue 1, pp. 94–98.

40 Paweł Gancarczyk, *Muzyka wobec rewolucji druku. Przemiany w kulturze muzycznej XVI wieku [Music in the Face of the Print Revolution. Changes in the Musical Culture of the 16th Century]* (Toruń: Wydawnictwo Naukowe Uniwersytetu Mikołaja Kopernika, 2011), p. 276.

words and the music – a separation of the virtuosity of voice from that of instruments, which in turn created the basis for the great advances in music during the 18th and 19th centuries.[41] Furthermore, owing to codified notation, it became necessary to clarify and even structure thought in a different manner, so as to fit the requirements of print.



Example 1. *Adieu mes amours*, the tenor part of the song by Josquin des Prés from *Harmonice Musices Odhecaton A*, the first collection of music printed using movable type in 1501, in Venice

The spread of print entered a new phase in the 19th century, owing to popular press and mass publishing. One of the more notable achievements in that regard was also the telegraph connection between Europe and America, launched in 1858. Owing to the invention of the Morse code, press agencies were then able to connect their field offices all over the world.

Music, or, it should be said, music life in its broadest sense, has been gaining coverage in the press ever since the beginnings of the latter. Concert announcements and reports, interviews with artists – all of this could be found in any popular magazine. The outstanding works thus attained an ever stronger presence in the public consciousness, no longer merely through presentations in concert, but also through the reflections of critics and the sphere of cultural resonance. People started obtaining information about particular composers

41 McLuhan, *Zrozumieć media...*, p. 362.

and their works through the media of public communication, and it was these very media that started contributing to the shaping of the musical tastes of the eras.

Electronic media may have not eliminated print, but they have made publishing even more of a mass affair – easier to assemble, produce and distribute. Furthermore, they were able to come into being and exert their influence separately from physical objects – that is, they started to exist in the form of files, e-books and online publications. The same holds true for music literature – in our day, many, even little-known, classical scores may be readily found online.[42] Composers have also been setting up websites where they post items like their biographies, press materials, links to articles, interviews, and extracts or even entire scores of their own works.

1.1.3. Towards audiovisuality – from classic photography to virtual reality

Technical inventions, rapidly absorbed, not just into everyday life, but also to the arts, have been of paramount importance for the development of media culture. In 1996, Peter Weibel, an artist and theoretician associated with new media, presented an eight-stage historical model, marked by successive pivotal discoveries and technologies:

— photography;
— telegraph, scanner (the beginning of 'new visual worlds');
— film (audiovisual simulation of reality);
— discovery of the electron;
— magnetic recording technologies (cassette tapes);
— transistor, integrated circuits and microprocessors;
— networked interactive technologies;
— connecting the interface directly to the human body and brain, neurological engineering.[43]

For Weibel, the evolution of media doubles as the history of its applications. It represents a linear process aiming to continuously increase the dematerialisation of the message, especially in the case of images.

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42 The largest open online music library is the IMSLP/Petrucci Music Library, boasting over 250,000 scores in its collection. See: http://imslp.org.

43 Peter Weibel, *The World as an Interface* [in:] *Electronic Culture. Technology and Visual Representation*, ed. Timothy Druckrey (New York: Aperture, 1996), pp. 338–339.

The author adopts a teleological approach, treating digital electronic media as the direct climax of historical processes and the beginning of the interface world.[44]

Other historical approaches, presented, for example, by Richard E. Mayer, emphasise the role of d i g i t a l i s a t i o n, whose idea goes back to the concept of a universal, algorithmic Turing machine constructed in 1936. This theory posits that the media revolution (including the emergence of the computer and the expansion of digital electronics) was driven first and foremost by advances in mathematical-type thinking. At the same time, Mayer, in opposition to Weibel, does notice the historical fortuitousness of the development of computer media. Many researchers emphasise that media are constantly evolving and never quite reach a final form:

> The technological revolution is a myth or at least a trend that has been going on for at least two centuries. Currently, we are entering a 'second phase' of new media research – a situation in which, following the enthusiasm of the 1990s, a certain kind of vogue for deconstructing previous concepts and terms related to describing media is emerging.[45]

The emergence of digital media – virtual, networked, convergent – is most certainly a breakthrough. However, it is difficult to view it as the end of history, as Weibel would have it.

New ways of capturing and disseminating images were set in motion by p h o t o g r a p h y, invented in 1839 by Louis Daguerre. Starting in the 1880s, photographs were already being successfully printed.[46] In 1891, Gabriel Lippmann patented colour photography, and Thomas Edison patented the m o v i e c a m e r a (*Kinetograph*) and a kind of video viewer (*Kinetoscope*). The first hand-held camera – the aeroscope – was patented in 1909 by Kazimierz Prószyński.[47] For several decades, cameras were not equipped with any kind of sound recording device; due to this, only silent films were available, with live musical accompaniment by what were known as 'tapers'. The

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44 Lister, Dovey, Giddings, Grant, Kelly, *New media*…., p. 84.

45 Mirosław Filiciak, *Użytkownik jako producent. Ku genealogii nowych mediów [The User as Producer. Towards a Genealogy of New Media]* [in:] *Nowa audiowizualność – nowy paradygmat kultury? [New Audiovisuality – a New Paradigm of Culture?]*, eds. Eugeniusz Wilk, Iwona Kolasińska-Pasterczyk (Kraków: Wydawnictwo Uniwersytetu Jagiellońskiego, 2008), p. 265.

46 Until then, cartoonists reproduced from daguerreotypes.

47 His company, Pleograf, made the first Polish feature films in 1902 – *Cabman's Adventure* and *Powrót birbanta (The Return of a Merry Fellow)*.

soundtracking of cinema took place in the 1920s. Ever since, visual and auditory messages have increasingly fused together to dominate mass culture after a mere few decades.

The first attempts to construct a t e l e v i s i o n date back to the 1870s.[48] In 1897, Karl Braun developed the electron tube, and Jan Szczepanik patented the t e l e c t r o s c o p e – a design for a television set could not yet be fully implemented for technological reasons. The term 'television'[49] appeared as early as 1900, but the first regular public broadcasts were not made until 1929. In the 1930s, the audiovisual e l e c t r o n i c c a m e r a was created, and the receiving device was already commonly referred to as a television set. The first demonstrations of colour television took place in the USA in 1950; in Europe, the development of this new medium was effectively stopped dead in its tracks by the war. The first major event to be televised by most of Europe's television channels were the Summer Olympics in Rome (1960). In Poland the Doświadczalna Stacja Telewizyjna [Experimental Television Station] began operating in 1952. Starting in 1956, Polish television already had regular programme broadcasts, but colour did not appear on screens until the 1970s. As image resolution gradually improved, the techniques for transmitting the sound layer were also perfected: from an analogue, 'noisy' mono signal to a digital-quality, multi-channel hi-fi[50].

A revolution in high-speed global communication, especially in the field of television, was brought about by active communication s a t e l l i t e s . In 1962, the US company AT&T launched the first device of its kind, called Telstar, into orbit around the earth. With the aid of English and French companies, the satellite facilitated the transmission of telephone calls, television calls and all kinds of data. Some of the several thousand satellites currently orbiting in space

48 It was then that an Irish telegraph operator, Joseph May, discovered the photoelectricity of the selenium plate. When the plate is exposed to sunlight, its resistance changes – these changes may be converted into an electrical signal and transmitted over a distance.

49 The first live wireless transmission was successfully carried out in 1925. As early as 1927, realistic scenes were shown in a system of 30 lines per frame and 5 frames per second. In 1928, Dénes Mihály presented a similar, improved device: the Telehor. At the time, Vladimir Kosma Zworykin was working on an electronic system for transmitting images using his invention, the iconoscope – an analysing electron tube. He also perfected the cathode ray tube, so that in 1929 he was able to present a recording at 24 frames per second.

50 The term hi-fi (high-fidelity) means high sound quality.

form a separate navigation system, known as GPS (Global Positioning System). Towards the end of the 20th century, it became apparent that this invention, too, could be employed in art, including music.

The development of television and the combination of image and sound has provided the opportunity for greater involvement of the viewers' perception, or, if you will, their 'sensory immersion'. This effect is more easily achieved in multimedia environments – in what is called virtual reality (VR). Designs for such environments were initiated in art as early as the 1960s,[51] but only gained mass popularity through computer games. Their development was determined by the rapid advances of microprocessor technology from the 1980s onwards, as well as audiovisual spatialisation (also known as 3D). It was then, when for the first time in history, art came into contact with the tools capable of faithfully simulating and 'falsifying' reality (hyperrealism) or creating it from the ground up (virtualism). In this context, the age-old idea of artistic *mimesis* entered a whole new dimension.[52]

1.1.4. Sounds remembered – analogue and digital phonography

The invention of musical notation helped in preserving music, as an artist who could read the notes would be able to reproduce it. This only changed in the late 19th century, when methods of acoustic sound recording came into being.[53] The invention of the phonograph and gramophone was to music what the spread of printing was to words and speech, and photography to natural landscapes.

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51 In 1960, the American artist Marton Hellig constructed the Sensorama – a capsule inside which one could watch panoramically-positioned screens intended to make the world depicted on the monitors resemble the real world.

52 Roman Konik, *Wirtualność jako rehabilitacja iluzji [Virtuality as the Rehabilitation of Illusion]*, *Diametros*, 2009, issue 21, p. 78, http://www.diametros.iphils.uj.edu.pl/pdf/diam21konik.pdf.

53 'The first step was probably taken by an Englishman, Thomas Young. (...) Versatile and educated, he carried out research in many fields, such as physics and medicine, as well as music (developing, for example, his own method for tuning instruments). He is credited with having left a detailed description of the sound recording device. Édouard-Léon Scott de Martinville, a French publisher and bookseller, is said to have consulted the document; he constructed what was known as a phonoautograph based on it. Unfortunately, this only recorded the sound wave (which was captured by a special tube, then converted into mechanical vibrations by a membrane) in the form of a graph. He was granted a patent in March 1857 and created a series of recordings. What is interesting is that archival recordings of sound waves, dating back to 9 April 1860, were found in 2008, and, through the use of sophisticated

In 1878, Thomas Edison patented his p h o n o g r a p h, which was able to record sounds on a tinfoil, and later wax cylinder.[54] However, no technology allowing cylinders to be copied *en masse,* like in the case of print, had been developed until the 20th century – once a piece of music was recorded, it was sold as a single copy. In order to sell another one, it was necessary to re-record the sound altogether – something that may seem quite peculiar in our day and age.

It was not until 1887 that Emil Berliner, working in the USA, but himself of German origin, patented the g r a m p h o n e. It was distinguished by its use of flat shellac discs and, more importantly, it was possible to make copies of such discs. It was intended to serve as an acoustic notepad and a tool for creating audio postcards, but buyers quickly repurposed the medium[55] by annexing it to the world of entertainment. Thus, the phonographic industry was born, reaching the worth of over $100 million as early as by 1921.

In the words of McLuhan, 'like the radio that it still provides with program content, the phonograph is a hot medium. Without it, the twentieth century as the era of tango, ragtime, and jazz would have had a different rhythm';[56] it 'created (…) a means to access all the music and speech of the world'.[57] Michał Libera, on the other hand, views this new medium as a contribution to a total revolution separating 'two modes of reproduction – the graphic symbol from the sculpture made by the sound wave; sight from hearing and, by extension, reading from listening; performance from reproduction, as well as interpretation from confrontation'.[58]

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computer software they could be converted back into sound. It turned out to be a recording of a voice, most likely of the constructor himself – specifically, a performance of a fragment of the folk song *Au clair de la lune*. Today, it is widely regarded as the oldest known and reproduced sound recording, Dariusz Mazurowski, *Rozwój technik nagraniowych i obróbki dźwięku [The Development of Recording Techniques and Sound Processing]*, *Muzyka 21*, 2011, issue 7.

54 Around the same time, a similar discovery was made in Europe by Charles Cros from France, who, unlike Edison, did not have a business background and did not make his invention widespread. See: Patryk Gałuszka, *Historia fonografii – od Edisona do płyty kompaktowej [History of Phonography – from Edison to the Compact Disc]*, http://pga.blox.pl/2007/06/Historia-fonografii-odEdisona-do-plyty.html.

55 Filiciak, *Użytkownik jako producent…*, p. 267.

56 McLuhan, *Zrozumieć media…*, p. 357.

57 McLuhan, *Zrozumieć media…*, p. 359.

58 Michał Libera, *Przekręt [Scam]*, MOCAK Forum, 2011, issue 1, passage available at: http:// www.mocak.pl/michal-libera-przekret.



Example 2. Thomas Edison with his phonograph, 1878



Example 3. Emil Berliner's gramophone, 1896

In 1948, shellac discs finally gave way to vinyl records. These, in turn, were characterised by higher sound quality and a greater capacity, allowing music to be played continuously for at least a dozen minutes at a time. This allowed publishers to finally embrace more voluminous classical works, rather than merely popular songs lasting around three minutes. It was then that the division between a single (a disc containing one song per side) and the long play became clarified[59].

Almost at the same time, the m a g n e t i c t a p e sound recording technology evolved, quickly and radically revolutionising work in recording studios. The precursor of the tape recorders invented later was the telegraphone, invented by a Dane, Valdemar Poulsen. Originally, this invention's recording mechanism used a steel wire, then a steel tape (and this kind of tape was what the British Broadcasting Corporation (BBC) first used to broadcast a radio programme in 1932). The first functional recording and playback device employing this technology, the Magnetophon K1, was demonstrated in 1935 at the Radio Exhibition in Berlin, which allowed the invention to become popular even before World War II.[60] This invention, which revolutionised the world music, became possible after the invention of a lightweight-yet-strong magnetic tape on a celluloid substrate, which one could, much like film tape, be cut and glue together.[61] Among the most popular audio storage devices was also the c o m p a c t c a s s e t t e, available on the market since 1963. Interestingly enough, almost from its beginnings, it was also used as a storage medium for 8-bit computers still popular in the 1980s, such as Atari and Commodore.

Owing to the explosive growth of the record industry, electronic audio equipment became widespread.

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59 An LP ('Long Play') is typically a 12-inch wide, 33⅓ rpm disc while an SP ('Single Play') is a 7-inch wide 45 rpm 'small disc'. A more capacious variation of the latter is the EP ('Extended Play').

60 Dating back to November 1936 is the oldest tape recording of a performance of Mozart's *39th Symphony* by the London Philharmonic Orchestra in Ludwigshafen.

61 Kotoński, *Muzyka elektroniczna* (Kraków: Polskie Wydawnictwo Muzyczne, 2002), p. 18.

> [The hi-fi quest for 'realistic sound'] soon merged with the TV image as part of the recovery of tactile experience. For the sensation of having the performing instruments 'right in the room with you' means striving toward the union of the audile and tactile in a finesse of fiddles that is in large degree the sculptural experience.[62]

Through reciprocal complementing – of the image by the sound and of the sound by the image – the message became stronger, allowing the viewer the illusion of direct presence.

In retrospect, the possibilities afforded by analogue technologies come across as woefully limited, and yet, artists often find themselves returning to them – and not merely for sentimental value. Vinyl records are issued as collector's pieces and publishing 'rarities', DJs and improvising artists still use vinyl discs for obtaining scratching sounds, and studios sometimes employ tube amplifiers for their softer and 'warmer' sonic qualities. The availability of digital means has, therefore, not rendered the old technologies entirely obsolete – they can be freely combined in new, convergent[63] configurations.

Experiments with d i g i t a l s o u n d r e c o r d i n g were initiated as early as in the early 1960s[64]. However, recordings of high quality were still not obtained until over a decade later. The first recordings using digital sound recorders were made in 1977. Digital media carriers, though, were still not available, so records were made using analogue technologies, usually on magnetic tape, adding the notation 'Recorded Digitally'. The digital tape recorder, that is, a computer system for digitally recording and reproducing sound, replaced the ordinary tape recorder in the 1980s. The acoustic signal's digital form permitted the introduction of various modifications to the signal, such as: filtering, modulation (including artificial reverberation) or the elimination of unwanted components – no longer through special, voltage-controlled modules, but through arithmetic, numerical operations and the use of special software.[65] Digital music takes the form of bits – endless strings of zeros and ones – no matter where or how they were recorded. Audio files may thus be stored on computers, music players, mass storage devices and, more recently, ever more often on Internet servers, i.e. in a digital cloud.

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62 McLuhan, *Zrozumieć media...,* p. 363.

63 Convergence is, among other things, the growing alike and intermingling of analogue and digital forms of media.

64 Kotoński, *Muzyka elektroniczna…*, p. 220.

65 Kotoński, *Muzyka elektroniczna…*

Another invention to revolutionise the electronic market owing to digital recording technology was the c o m p a c t d i s c . The smaller size, along with the greater capacity[66] and the higher sound quality, were appreciated by classical music listeners and pop-culture-hungry audiophiles alike, as the advent of the CD marked the end of the era of noise and interference.[67] The needle of the turntable was replaced by a laser beam, and the vinyl record by a silver-coloured plastic disc.[68] Digital playback systems entered the Asian market in 1982, dominating the music phonography sector within a mere decade. Quickly enough, the compact disc also became a versatile medium for other multimedia, allowing the storage of films, photographs, texts and software.

Over time, the studio recording, originally intended as a recreation of the concert setting, became the main focus of musicians, in particular those associated with the pop culture community. Paradoxically, it was the concerts that became the simulation of an ideal, model recording for performers and listeners alike.[69] This moment seems opportune to adduce the words of the famous pianist Glenn Gould, who, overjoyed by the new recording technologies, abandoned concerts in the mid-1960s, at the height of his career, to dedicate his time to studio recording: 'the public concert as we know it today would no longer exist a century hence, since its functions would

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66 A vinyl record has enough space for approximately one hour of music. This time, however, is divided between the two sides of the disc. The compact disc has the capacity to store more than 70 minutes of sound recordings and allows reproducing it with no interruptions, which is about the same amount of time as in the case of the cassette tapes available at the time. One anecdote circulating in the industry states that such a capacity was determined by the average duration of Beethoven's *9th Symphony*. Importantly, the increase in disc capacity had an impact on how much music was released on an album, and, as a consequence, changed the very notion of an album in the minds of artists and audiences.

67 One ardent advocate of digital recording was the renowned conductor Herbert von Karajan, who, after having heard digital recordings of his orchestra, declared everything else to be a relic of the past.

68 Consequently, the CD does not wear out as a result of the grooves being abraded by the needle, which allows them to maintain excellent sound quality notwithstanding the playback frequency. Minor scratches on the record surface also do not have as much of an impact on the sound quality as they would on a vinyl record.

69 Recently, it has become popular, especially in televised broadcasts, to produce pseudo-concert shows using playback technology, which entails the soundtrack being played from recordings rather than performed live; to put it colloquially, the musicians are merely faking real playing.

have been entirely taken over by electronic media',[70] he claimed. In our day, it is abundantly clear that these words did not come true after all, and touring is still an important aspect of every musician's artistic activity, but they do show what a breakthrough phonography had made at the time. Up to that point, music would only materialise through one-off, unique concert performances. In the 20th century, 'for the first time in world history', says Walter Benjamin, 'the technological reproducibility of the work of art emancipates the work from its parasitic subservience to ritual'.[71] Digital recording was also a pivotal step towards achieving virtual sound, as it is so accurate that perception could mistake it for real, natural sound.

1.1.5. Ubiquitous sounds – telephone and radio

In 1876, Alexander Graham Bell obtained a patent for the t e l e p h o n e, whose working principle entailed converting sounds into electromagnetic waves and subsequently reversing the process. Initially, people sought to use telephones as a medium for radio broadcasts, but the new invention soon came to be used by the press and news agencies, revolutionising the way information circulated. The r a d i o, i.e. a wireless sound transmitter, was invented by Nikola Tesla but patented and presented by Guglielmo Marconi on Christmas Eve 1906, when the first radio broadcast was made. In 1908, the first European transmission was set up, using a transmitter placed on the Eiffel Tower. The initiator of transmission was the brilliant American inventor, Lee de Forest, who in the early 20th century built the audion – the ancestor of the transistor.[72] It was employed for the first live broadcast of a performance from New York's Metropolitan Opera in 1910. In the same year, the distribution of the first home receivers began in New York. 1920 saw the foundation of the first radio

70 Glenn Gould, *Perspektywy nagrań [The Prospects of recording]* [in:] *Kultura dźwięku. Teksty o muzyce nowoczesnej [Audio Culture: Readings in Modern Music]*, eds. Christoph Cox, Daniel Warner (Gdańsk: Wydawnictwo słowo/obraz terytoria, 2010), p. 152.

71 Walter Benjamin, *Twórca jako wytwórca [The Author as Producer],* ed. Henryk Orłowski, translated by Henryk Orłowski, Janusz Sikorski (Poznań: Wydawnictwo Poznańskie, 1975), p. 274.

72 This invention permitted the rapid development of the radio, television and radar, and had a great impact on the invention and development of the computer. Audion is a kind of high-sensitivity detector that permits one to pick up radio stations from a considerable distance. A method for the optical recording of sound on film (the Photion method) was also developed by Lee de Forest.

station; by 1923, more than five hundred stations were in operation. In 1924, trial broadcasting began in Warsaw, where Polish Radio was launched two years later.

The radio, being the most important sound mass medium, had a radical impact on the world of music, including the spread of popular genres and jazz, especially in the United States, outcompeting player and upright pianos, the previous tools used for making music at home. These new media have contributed to the partial restoration of 'the vocal, auditory, and mimetic world that had been repressed by the printed word'.[73]

The ability to enter into direct contact on a global scale resulted in an opportunity for people to detach from their territorial spatial relationships. One could say that, owing to media such as the radio, the world changed in size. Previously huge and unattainable, it now seemed like a 'global village'. Piotr Gawrysiak maintains that, owing to the impact of the dynamically developing media, the traditional model of content creation and distribution was shaken.[74] As the French sociologist Pierre Bourdieu proclaimed in his theories, the media made a stronger entry into the 'field of cultural production'.[75] Owing to their immediacy and ubiquity, both phonography and the radio made a huge impact on 20th century culture, high and popular alike ('radio created the disc jockey'[76]). For one, the expansion of new musical trends (blues, jazz, rock'n'roll) would not have been possible without the sales of several million records and popular radio programmes. Radio was also used in the quality of an instrument in works by composers like John Cage in *Imaginary Landscape No. 4*, (1951), where an 'orchestra' of twelve receivers served as the ensemble.[77]

The creator of the telephone, Bell, made another important discovery on the sidelines of his research. As he refined his devices, he created his first m i c r o p h o n e in 1878. However, his early, purely acoustic recording methods were fraught with undesired resonances

73 McLuhan, *Zrozumieć media...,* p. 361.

74 Piotr Gawrysiak, *Cyfrowa rewolucja. Rozwój cywilizacji informacyjnej [The Digital Revolution. The Development of the Information Civilisation]* (Warszawa: Wydawnictwo Naukowe PWN, 2008) p. 5.

75 Pierre Bourdieu, *Reguły sztuki: geneza i struktura pola literackiego [The Rules of Art: Genesis and Structure of the Literary Field]* (Kraków: Universitas, 2001).

76 McLuhan, *Zrozumieć media...,* p. 391.

77 Similarly, in the works: *Speech 1955* for a radio announcer and 5 radio receivers (1955) and *Radio Music* for 1 to 8 performers using radio receivers (1956).

of the sound collection tube; they also had limited sensitivity and frequency range, especially in the low and very high registers. One great technological breakthrough in recording was the conversion of the acoustic signal received by the microphone into an electrical signal, first employed in the 1920s. This made it possible to record quiet and distant sounds by making use of electronic amplification, but also finally permitted the use of electronic amplification and filtering. This, in turn, encouraged artists to employ these new techniques in art, thus giving birth to the *musique concrète* trend.

1.1.6. The digital revolution – computers and the Internet

Techniques for capturing, processing and transmitting all types of information – sounds, images and other data – combine modular digital media which permit a 'richer' use of electronic devices. Central to this digital revolution is the computer and its rapid development in the latter half of the 20th century.

The first differential and analytical machine, a prototype calculator of sorts, was created in the 19th century by the English mathematician, astronomer and mechanic, Charles Babbage. Years later, his concepts were utilised by John von Neumann, one of the founding fathers of computer technology's theoretical foundations. However, the creation of a universal digital machine necessitated several other inventions: Claude Elwood Shannon, whom many consider to be the father of the digital revolution, developed the binary system[78] and prophetically claimed that text, images and sound could be described using strings of zeros and ones. In 1937, independently of each other, Shannon and George Stibitz constructed electrical circuits. Shannon created the first MANIAC computer, whose applications ranged from playing chess games to constructing a hydrogen bomb. In 1957, the first computer composition was created: it was called *Illiac Suite*. Its name came from the computer used to generate musical scores by Lejaren Hiller and Leonard Isaacson. At the same time, recalls Włodzimierz Kotoński, the first attempts at computer speech synthesis took place, contributing, in turn, to creating a new technology in electronic music – digital sound synthesis.[79]

78 At the same time, Lee de Forest also designed a player piano that played preprogrammed musical pieces in a random order.

79 Kotoński, *Muzyka elektroniczna…*, p. 215.

The first transistors – the point-contact transistor, then the more practical junction transistor – were created between 1947 and 1950 at the Bell Telephone laboratories[80]. This invention constituted an unquestionable breakthrough in electronics, as it relegated the large, failure-prone, energy-intensive electron tubes to the background, giving rise to the miniaturisation of electronic instruments and devices and lowering their power consumption. This led to the creation of the IBM 704, the first computer with an operating system, in 1954. A few years later, in 1958, the integrated circuit – that is, an integrated system containing a large number of electronic components such as transistors, diodes, resistors and capacitors – was built and presented. In the 1970s, a further step in the development of computers was made possible by the microprocessor, which further integrated many integrated circuits. In 1975, an American of Polish descent, Steve Wozniak, working together with Steve Jobs, built the Macintosh – a small personal computer with a universal, user-friendly screen interface that could be used by any home user. Then, IBM's first PC (Personal Computer) found its way onto the market in 1981.[81] It was then when the era of popular personal computers, such as Commodore and, later, Atari and Amiga, began. They all found their way into the hands of the artists, facilitating their work, but also spurring the quest for new technological solutions.[82] Importantly, they were not used to merely produce sound material, but also to support research work on the acoustic properties of sound and the various aspects of musical analysis.

Digitalisation – or, in other words, reduction to binary code – brought about a change in the way data was stored, reproduced and processed. The computer, on the other hand, by combining all media possibilities into a single multimedia device, revolutionised all previous inventions, marking the beginning of a new 'interactive,

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80 In 1956, the Nobel Prize in Physics was awarded to John Bardeen, Walter Houser Brattain and William Bradford Shockley for their invention of the transistor.

81 Engineers from Poland had a sizable number of contributions to the IT revolution. In the early 1970s, a Polish electronics engineer, Jacek Karpiński, created a prototype of a minicomputer personal computer called the K-202; it surpassed the first IBM PC in terms of speed and permitted multitasking, multiaccessibility and multiprocessing, http://legendy-prl.pl/microcomputer_k-202.html.

82 By the mid-1980s, more than a hundred computer music centres around the world were in existence already; Thom Holmes, *Electronic and Experimental Music*, Routledge, New York 2001, p. 216.

telematic culture'[83]; it was no longer a mere tool for arithmetic calculations, and became a universal information converter. It is able to effortlessly replace any other medium, because it can simulate all of them.

In the 1950s – with the advent of the first computers – the idea of a distributed digital data transmission network was born. In 1958, ARPANET, a new communication technology designed for military purposes, was launched.[84] In 1973, the first international connection was established between England and Norway, and by 1980 ARPANET already had 400 servers running in various military, government and university institutions.[85] The multiplicity of its uses led to the separation of the civilian part of this network in 1983; at the dawn of the 1990s, it was called the i n t e r n e t .[86]

New network media opened the way for alternate, virtual forms of publishing and created a challenge for traditional publishing houses. The Internet enabled quick, global access to all sorts of data: textual and hypertextual, auditory, visual and audiovisual. What is important is the fact that the user is sometimes able to interact with the content of the message.[87] On the other hand, the beholder, having to navigate and constantly make choices, needs a broader range of 'pre-knowledge' and put more effort into understanding the meanings of the communication.

The breakthrough that is taking place owing to new media is most easily seen in the way of life of successive 20th century generations. In our day, a generation of people 'born with a mouse in its hand'[88] is

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83 Lister, Dovey, Giddings, Grant, Kelly, *A Critical Introduction…*, p. 86.

84 This system is difficult to destroy, as the disruption of a few nodes does not result in the destruction of the entire network.

85 Also credited with creating the decentralised network system was Paweł Baran, who implemented its idea based on the exchange of data packs. Dividing the information up into parts allowed its transfer between different computers using a single cable. A year later, the TCP/IP protocol was established, owing to which the language of computers could be standardised. To this day, this protocol is still the basis for network connections.

86 Poland was only connected to it following the political changes, in 1991.

87 An important problem that manifested with the spread of the Internet is the blurring of the boundaries between publisher, producer, distributor, consumer and critic of the message. It is also much more difficult to pinpoint the place of new media when it comes to the exercise of power and social control.

88 Magdalena Szpunar, *Urodzeni z myszką w ręku [Born with a Mouse in Hand]* [in:] *Komputer w edukacji [The Computer in Education]*, ed. Janusz Morbitzer (Kraków: Katedra Technologii i Mediów Edukacyjnych Uniwersytetu Pedagogicznego), 2009.

growing up, preferring to participate in culture not in a direct manner, but rather through new media – especially through the Internet. Many young people – and an increasing number of older people – elect not to visit cinemas or museums, or to buy books or records, preferring to satisfy their desire to participate in culture through their virtual representations. Instead of traditional museums, for instance, virtual workshops, archives and medialabs[89] open to everyone are organised; instead of schools, e-learning platforms are being founded. As aptly predicted in the mid-1930s by Paul Valéry:

> Just as water, gas, and electricity are brought into our houses from far off to satisfy our needs in response to a minimal effort, so we shall be supplied with visual or auditory images, which will appear and disappear at a simple movement of the hand, hardly more than a sign.[90]

For culture, the Internet has become a medium that eludes being fully mastered, as it is the only independent mass medium. Portals such as YouTube, Vimeo, the social networking site Facebook and many others are stepping into the role of interactive television, also fulfilling the function of a virtual open stage – the media space of next-generation culture – at the same time. Television, an institutional mass medium, is rarely of service to classical music, as it only piques the interest of a modest percentage of the audience. The internet, therefore, being a free and non-hierarchical medium, has the potential to break the deadlock suffered by high art, stifled between the spaces of pop culture.[91]

Owing to ever newer digital technologies and tools, the media of the 21st century are developing so rapidly and transforming so much that, according to Paul Levinson, one could already speak of 'new new media'.[92] For the first time ever, the viewer, using easy-to-use and often mobile forms, such as a smartphone or a tablet, may obtain access

89 Medialabs act as institutions for the exchange of information and the implementation of projects with the use of new media and technologies.

90 Paul Valéry, quoted in: *Dzieło sztuki w dobie możliwości jego reprodukcji technicznej [The work of art in the age of the possibility of its technical reproduction]* [in:] *Wiedza o kulturze. Część IV. Audiowizualność w kulturze. Zagadnienia i wybór tekstów [Knowledge of Culture. Part IV. Audiovisuality in Culture. Themes and Selection of Texts]*, J. Bocheńska, A. Kisielewska, M. Pęczak (Warszawa: Wydawnictwa Uniwersytetu Warszawskiego, 1993), p. 273.

91 Accessibility and ease of search mean that even alternative genres that, by virtue of their nature, thrived on the fringes of the commercial music market, managed to enter the scope of pop music.

92 See: Paul Levinson, *Nowe nowe media [New New Media]*, translated by Maria Zawadzka, Wydawnictwo WAM, Kraków 2010.

to knowledge and information, and is also able to present any kind message – text, photo, video – ensuring global access. The Internet has become an excellent medium for spreading music in an audiovisual form as well. It is currently the largest publicly accessible digital audio and video library in the world. Levinson, perhaps not without a hint of exaggeration, puts the significance of this revolution on par with the invention of the alphabet.

1.1.7. Total convergence – the digital revolution

As pointed out by Zbigniew Bajka, the history of computer technology is quite short: 'it's been just over 50 years. But it was the last 30 years that have, in fact, been a revolution that has indirectly influenced the development of virtually all means of mass communication.'[93] This revolution reached much deeper than those in the past. Like the printing press five centuries back, the computer and the Internet are at the centre of a media breakthrough, transforming all areas of life: culture, production, distribution, and communication. They have also transformed all of the existing media: texts, still and moving images, sounds, and spatial structures. And thus, art was freed from the constraints of the physical medium. This, however, has given rise to the need for a new cognitive framework and new tools for interpretation.

The 20th century, which saw its development unfold under the influence of audio-visuality, came to an end at a time marked by multimedia culture and cyberculture; the century popularised the photographic and acoustic reproduction of reality and saw the implementation of techniques of simulation and virtualisation. A series of technological and conceptual developments over time have led to the transformation of all media, but the 'old' media have by no means been discarded or forgotten. Oftentimes, their transformation process combined traditional and innovative elements alike. Initially, the new measures initially reinforced the old ones and took over their conventions and language. As pointed out by Manovich, new media are analogue media converted to digital form, which only intensified their effect – they are old media, but 'squared'.[94]

The traits of old and new media can be summarised in the following manner:

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93 Zbigniew Bajka, *Historia mediów* [History of the Media] (Kraków: Wydawnictwo i Drukarnia Towarzystwa Słowaków w Polsce, 2008), p. 208.

94 See: Lev Manovich, *Język nowych mediów [The Language of New Media]* (Warszawa: Wydawnictwa Akademickie i Profesjonalne, 2006).

Table 1.
Key features of old and new media

Old media	New media
analogue	digital
local	global
not mobile	mobile
single-function	multifunctional, universal
closed	open
not translatable	interchangeable
divergent	convergent
permanent	variable
passive	active
physical	virtual
hierarchical	non-hierarchical
single/double-medial	multi-/inter-/transmedial
strong	weak
ordered	chaotic

The digital revolution caused a total c o n v e r g e n c e in the fields of media of organisation, distribution, reception, and regulation. As a new medium, the essence of the Internet is that it incorporates all of the old analogue media – namely radio, film, and television. In art, too, the end of the 20th century saw the manifestation a kind of interpenetration of all art disciplines – a cultural hybridisation,[95] or a syntopia of art, science, and technology.[96] Owing to this, the transformations of contemporary culture may no longer be understood in their entirety without contemplating the complex, intertwined relationships existing between their spheres of action. Simultaneously, the multimediaisation of art at the turn of the 20th century fits in with a certain renaissance of sensuality.[97] Coming to the fore are also tendencies transcending corporeality, i.e. towards the transhuman and cyborgism,[98] claiming the human body to be an outdated structure that is not suited to electronic reality, needing the extension of its senses and redefinition through new media.

95 Edmond Couchot, *Sztuka medialna: hybrydyzacja i autonomia [Media Art: Hybridization and Autonomy]*, *Czas Kultury*, 2006, issue 5–6, pp. 58–63.

96 See: Piotr Zawojski, *Cyberkultura. Syntopia sztuki, nauki i technologii [Cyberculture. The Syntopia of Art, Science and Technology]* (Warszawa: Wydawnictwo Poltext, 2010).

97 Wilkoszewska, *W krainie czucia i bezczucia, czyli o zmysłach głównych, zapomanych i sztucznych [In the Land of Feeling and non-Feeling, or of the Main, Forgotten, and Artificial Senses]* [in:] *Wymiary piękna. Z badania estetyki sensu largo [The Dimensions of Beauty. From Studies on Aesthetics sensu largo*], ed. Maria Gołaszewska (Kraków: Wydawnictwo Uniwersytetu Jagiellońskiego, 1998), p. 250.

98 Some examples may be found in body art associated with new media, including the work of the artist known under the pseudonym Stelarc.

Over time, the convergence and versatility of digital media allowed tools that were initially intended for specific purposes to expand upon or even change their original applications. The original functions were adapted and absorbed by newer means, and they themselves were able to evolve and find new uses. One may notice such situations in music as well:

> Musical technologies are constantly re-appropriated and redirected to ends and uses other than those originally intended. The 'electric guitar' began as an amplified guitar and ended up as an entirely different instrument. The multi-track tape recorder was soon taken out of the hands of the engineer and placed into the hands of the composer. In the hands of the hiphop DJ, the turntable was transformed from a 'record player' into a live sampler and percussion instrument. And the computer glitch, once an unwanted digital error, became desirable sound material for many producers of contemporary electronica. Like the recorded sample, musical technology as a whole ceases to have any given or fundamental use value, but instead is laid open to endless transformation and redirection.[99]

Electronics have become an ubiquitous feature of the world of sound arts. Indeed, electronic means are even used in concerts of classical and symphonic music. Engineers and sound directors started considering themselves fully-fledged artists, and music was now treated as sonic qualities and structures that were most easily executed, shaped and explored using electroacoustic devices.

The proliferation of digital technology and devices in everyday life constituted a considerable change to civilisation and contributed to the emergence of a new type of social structures. Indeed, the reception of virtualised digital material – and its circulation in culture – is different from dealing with an analogue message. New media have become an escape from the passive culture of consumption. People are no longer the recipients of goods and have begun to actively create them. A society of interaction, digital natives, constructed along the lines of the internet network has taken shape: decentralised, rhizomatic,[100] neo-nomadic.[101]

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99 Christoph Cox, Daniel Warner, *Music in the Age of (Re)production. Introduction* [in:] *Audio Culture…*, p. 150.

100 The term 'rhizome' was proposed by Gilles Deleuze and Félix Guattari in their work *Capitalism and Schizophrenia*; see Gilles Deleuze, Félix Guattari, *The Rhizome*, translated by Bogdan Banasik, *Colloquia Communia* (1988), issues 1–3.

101 See: Anthony D'Andrea, *Neo-Nomadism: A Theory of Post-Identitarian Mobility in the Global Age*, *Mobilities*, 2006, Vol. 1, issue 1, pp. 95–119;

1.1.8. New media art – a new culture, or a return to the roots?

In 1839, when Paul Delaroche first saw the daguerreotype, he exclaimed: 'from today, painting is dead!'.[102] Fortunately, these Cassandran words uttered by the French portraitist did not come true. The media have not replaced (or destroyed) traditional art, but, rather, found their place – in forms, in genres, and in aesthetics. The two facets of art – traditional and new media – coexist and intermingle. The same holds true for music. The expansion of electroacoustics did not end up causing the formation of a homogeneous style, and neither has it become associated with any particular aesthetic. Rather, it is a certain way of making and practising music, a new and important technique or strategy that opens up nigh-unlimited creative possibilities.

New media have underpinned the radical transformations of modern civilisation and culture. Not only did they change the ways in which creators pursued the fulfilment of their goals – another thing to change were the goals themselves. As predicted by McLuhan, the age of print that ruled the world and elevated the rational mind, was followed by the age of electronic media, which in turn promotes the return of spontaneity. Television, for instance, restores the balance between the senses that prevailed in the pre-literate era and was disrupted by print. Contemporary continuators of McLuhan's thought point to how this trend is furthered by new media: their interactive nature means that culture is entering a new phase of development ('culture 2.0',[103] 'the third wave',[104] 'the third culture', or[105] 'cyberculture'[106]).

Natalia Skoczylas, *O współczesnym nomadyzmie [On Contemporary Nomadism]*, *Kultura-Enter* (June 2011), issue 35, http://kulturaenter.pl/article/o-wspolczesnym-nomadyzmie/.

102 Source of the quote: http://www.polskieradio.pl/39/156/Artykul/756279,Wynalazek-ktory-zmienilwidzenie-czlowieka.

103 Bendyk, Filiciak et al., *Kultura 2.0*...

104 Alvin Toffler, *The Third Wave* (New York: Bantam Books, 1980).

105 Kluszczyński, *Trzecia kultura. O współczesnych związkach sztuki, nauk i technologii [The Third Culture. On the Contemporary Relationships between Art, Sciences, and Technology]* [in:] *W stronę trzeciej kultury. Koegzystencja sztuki, nauki i technologii [Towards the Third Culture. The Coexistence of Art, Science and Technology]*, ed. Ryszard W. Kluszczyński (Kraków—Warszawa: Centrum Sztuki Współczesnej Łaźnia, Narodowe Centrum Kultury, 2011); Piotr Zawojski, *Trzecia kultura a cyberkultura [The Third Culture and Cyberculture]*, http://www.zawojski.com/2008/11/05/trzecia-kultura-a-cyberkultura/.

106 Zawojski, *Cyberkultura jako nowy paradygmat kultury medialnej. Rozważania teoretyczne [Cyberculture as a New Paradigm of Media Culture. Theoretical*

Walter Ong, an erstwhile collaborator of McLuhan's, views these phenomena in terms of 'secondary orality'. According to Ong, orality is returning with renewed strength, carried by mobile phones, radio waves, and television; it is making a comeback, reaching an ever-widening audience, and thus, in a certain sense, the author posits, it is claiming its place in the modern world. Secondary orality forms a joint community, but a much larger and stronger one than was the case with primitive tribes. Speech creates a shared space of time and personhood, for every word is a sound that is intangible and dynamic, and unites listeners. Writing, on the other hand, destroyed this community[107] and marginalised words in favour of the dominance of the iconosphere, transferring language from the auditory zone to the voiceless space of the visual.

Mediology is a branch of science dating back mere decades, but the history of media – in the broadest sense of that word – may be studied beginning from the Palaeolithic cave paintings at Lascaux. In the words of Mirosław Filiciak, 'the history of new media is not so much the history of the development of technology as the history of the social expectations accompanying this development'.[108] The phenomenon of the media revolution, after all, concerns not just 20th-century electronics, but also the wider historical and civilizational context.

Dieter Mersch proposes the division of civilizational epochs into three periods, with the following theories accompanying them: (1) the theory of perception (developed since antiquity), (2) the theory of language (beginning in the 17th century), (3) communication technologies dating from the 19th century, when electronic media emerged.[109]

Alvin Toffler, a sociologist interested in the 'media of the future', delineates three global revolutions, constituting civilizational and cultural 'waves':

1. N e o l i t h i c, breakwing the Mesolithic gatherer-hunter culture with settlement and the development of agriculture;

Considerations] [in:] *Nowa audiowizualność…*; Zawojski, *Cyberkultura...*; Kluszczyński, *Społeczeństwo informacyjne. Cyberkultura. Sztuka multimediów [Information Society. Cyberculture. The Art of the Multimedia]* (Kraków: Rabid, 2001).

107 Walter J. Ong, *Orality and Literacy: the Technologizing of the World*, translated by Józef Japola, Redakcja Wydawnictw KUL, Lublin 1992.

108 Filiciak, *Użytkownik jako producent…*, p. 264.

109 Mersch, *Teorie mediów* (Warszawa: Wydawnictwo Sic!, 2010).

2. I n d u s t r i a l, based on the mass civilisation (whose features were mass production, distribution, consumption, etc.);

3. P o s t i n d u s t r i a l, informational, digital, tied to electronic media.

It is not difficult to see that the media – first analogue, then digital – were the very foundation of the last two revolutions. These revolutions had an impact on the developments in the field of musical arts; transformations have taken place over long periods of time, though it is possible to identify breakthrough moments. The dominance of the voice as the natural and most common sound medium continued all the way until the Baroque. The consistent development of instruments, experimentation with their varieties, the continuous improvement of the skills of the performers, refinement, and, finally, the massification of their production contributed to the dominance of instrumental music in the 18th and 19th centuries. The era of new media began with the rapid expansion of electronic instruments: free of technical limitations and fully programmable. It is from here that comes the dominance of artificially-generated sounds in the music of the latter half of the 20th century – sounds emulating natural instruments, but also representing entirely new sonic qualities.

By looking from this broad perspective, one may see that in some aspects the history of music has come full circle. Contemporary audiences pay ever more attention to the non-sonic aspects of performance. Instead of radio broadcasting, they opt for audiovisual internet streaming; instead of CDs, they increasingly turn to concert recordings on high-capacity Blu-ray discs supported by Full HD, surround and, more recently, 3D stereoscopic technologies. When it comes to high art, single-sense perception sometimes even does not make sense anymore. After all, it is difficult today to imagine listening alone being sufficient to reach the essence of works created as performances or installations. This is reminiscent of the reality of ancient Greece, where music did not really exist as a separate form of art.[110] Its vehicle was the triune chorea – the unity ('oneness') of music, dance and poetry. It was a particular kind of synthesis, an integral fusion and co-constitution of sounds, text along with its prosody (meters), as well as gestures and body movements. Even when poetry finally detached itself from dance, it was still accompanied by music in performance (Homer was always depicted with a lyre). 'The great explosion of the

110 The Greeks had no prior knowledge of poetry, dance or music separately – not even a conceptual interpretation thereof. The term *musike* meant any art that was governed by the Muses.

Renaissance', reminds us McLuhan, 'that split musical instruments off from song and speech and gave them specialist functions is now being played backward in our age of electronic implosion'.[111] Through cultural changes, modalities are coming together again, and contemporary artists do not want to limit themselves to a single channel of perception. Activities that stimulate a single sense exhaust their potential, not matching the expectations and perceptual capabilities of the modern *homo electronicus*. The multisensory message, impacting the receivers synergistically and weaving them into a network of intermedial relationships, gains new power.

1.2. Electrophones – new sound media

As early as the beginning of the 20th century, a wide range of artists – especially the Futurists, with their avant-garde, radical views and manifestos – sought to integrate the advances of new technologies into the realm of art. In the world of music, however, this revolution was to be supported not just by composers, but also by engineers, electricians and – in a broad sense – inventors, oftentimes amateur musicians themselves. Indeed, the development of electronic instruments was inextricably intertwined with the emergence and evolution of the radio, telephone and gramophone. At the time, some acoustic laws and phenomena were discovered by accident, and musical inventions were made on the sidelines of research that was not directly related to sound.

Music, much like other arts, was very quick to incorporate the latest inventions (especially those in the field of communication technology), as evidenced by how many new instruments appeared in the first half of the 20th century, especially in its third and fourth decades. The considerable interest in electrophones as musical media of the future is consistent with the atmosphere of that time: the delight in the possibilities of new discoveries seemed to be the dawn of a new era. The avant-gardists, in particular, were attracted by the possibility of entering the world of open sonic qualities and the emergence of a new aesthetic situation, such as music performed without any direct human participation. Many conservative composers treated neither this attitude nor its executions seriously. They were regarded more as a curiosity – a flashy element of the popular music shows of the time.

111 McLuhan, *Zrozumieć media...*, p. 419.

The first half of the 20th century saw the invention and construction of several hundred new instruments. An examination of their history and development allows one to adopt a perspective useful in considering the origins and evolution of 20th-century electroacoustic music. Jaron Lanier posits that:

> Musical instruments have often been the most advanced technologies around, sometimes surpassing even the tools of war. More importantly, though, instruments are always the most eloquent technologies of an era. As the most eloquent machines, instruments predict the future of culture, when we will communicate increasingly through machines.[112]

According to Lanier, instruments are 'cultural and time travel machines', reflecting 'the collective body motion of a culture, and in playing an instrument one's body feels at least a trace of the movement gestalt of a people, something which is otherwise lost'.[113]

The literature on electrophones, including those pioneered at the beginning of the 20th century, is quite extensive. Many encyclopaedic entries, compilations,[114] calendars,[115] photo-documentations, etc. describing the most interesting and important of these have been created (even in cases where a given instrument had been lost, descriptions of its construction, principles of operation and musical possibilities have survived). However, this chapter does not constitute this type of collation and description, but rather aims to organise, classify and show the changes as well as the effects of their emergence for the world of music. It is also an attempt to construct a grid of concepts

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112 Jaron Lanier, *Instrument of Change*, CD booklet liner notes (POINT Music / Philips / PolyGram Records, 1994).

113 Lanier, *Instrument of Change*...

114 Francis W. Galpin, *The Music of Electricity: a Sketch of its Origin and Development,* "Proceedings of the Musical Association", 1937–1938, 64th session, p. 71; Stanley Karl Lewer, *Electronic Musical Instruments* (London: Electronic Engineering, 1948), p. 21; Alan Douglas, *Electronic Musical Instrument Manual: a Guide to Theory and Design* (London: Pitman, 1976), p. 31; Hugh Davies, *Electronic instruments* [entry in:] *The New Grove Dictionary of Musical Instruments*, Vol. 8, ed. Stanley Sadie (London: Macmillan, 2001), p. 67; Hugh Davies, *Electrophone* (entry) [in:] *The New Grove Dictionary of Musical Instruments*, Vol. 8…, pp. 110–111; Michael Bakan et al., *Demystifying and classifying electronic musical instruments*, *Selected Reports in Ethnomusicology*, 1990, Vol. 8, p. 37; Margaret J. Kartomi, *On Concepts and Classifications of Musical Instruments* (Chicago: University of Chicago, 1990), p. 162.

115 See: *120 Years of Electronic Music*, http://120years.net/wordpress/.

and give them context, as well as to outline the continuity of certain ideas. The contribution of electrophones was such that one may speak of a musical paradigm shift. It includes, above all, the willingness to:

— exceed human technical capabilities (speed, number of voices, etc.);
— increase the sonic possibilities within a single device;
— miniaturise instruments and make them more intuitive and easier to handle;
— automate performances or replace the performer altogether;
— control peripheral instruments in a centralised, remote manner.

1.2.1. Electronic, or active, instruments – terminology and attempts at creating a typology

At the beginning of the 20th century, the most popular concept for dividing instruments was the classification by Erich von Hornbostel and Curt Sachs, published in *Zeitschrift für Ethnologie* in 1914. It only included four groups: idiophones, membranophones, chordophones, and aerophones. Sachs did not add electrophones as a fifth group until 1940[116] (which had previously been suggested by Francis W. Galpin in 1937[117]), and once he did, he divided it into three subgroups in which:

— electricity is only used to drive the acoustic mechanism or to control the actuators;
— electricity is used to amplify the volume;
— vibrations are caused by purely electrical means (Sachs classified these instruments as radio-electric).

In the 1930s and 1940s, the terms 'electrotonic', 'electromagnetic', 'electrogenic' and even 'synthetic' were still used to describe instruments. Importantly, since the middle of the 20th century, the conceptual scopes of the terms 'electronic'[118] and 'electroacoustic', the terms used most commonly and widely now, have crystallised. But in retrospect, and, in a certain sense, over and above Sachs' division, three types of instruments can be distinguished:

116 Curt Sachs, *The History of Musical Instruments* (New York: W.W. Norton, 1940), p. 447, https://archive.org/details/TheHistoryOfMusicalInstruments.
117 Francis W. Galpin, *A Textbook of European Musical Instruments* (New York: Dutton 1937), p. 30.
118 Lewer, *Electronic Musical Instruments…*, p. 22.

— e l e c t r o m e c h a n i c a l (electric-acoustic), in which the electrically-powered mechanism serves not to produce sounds, but to merely transfer the fluctuations of the current into acoustic oscillations. This usually occurs via mechanical energy, e.g. via a diaphragm or air pressure (as in the wind chest of an electromechanical organ);
— e l e c t r o a c o u s t i c (acoustic-electronic, amplified), which produce sounds by acoustic means but are electronically amplified using built-in microphones and amplifiers (as is the case with the electric guitar);
— e l e c t r o n i c , in which both the source and resonance (amplification) of the sound are excited using electrical circuits with active components.[119]

The term 'electric', which is still popular today, is therefore only used to refer to certain electricity-powered devices. It should not be used in the context of instruments with transducers and amplifiers, i.e. using amplification that is inherently electronic.[120] Curt Sachs, too, uses the term 'electric' only for distinguishing instruments in which a mechanical or pneumatic system is replaced by an electric one (e.g. an organ with an electric tracker action).[121]

Various types of transducers are used in electroacoustic instruments – including both those for sound recording and for playback – to convert acoustic energy into electrical energy (and vice versa). One may divide those into several groups:

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119 According to *The New Grove Dictionary of Music and Musicians*, electronic instruments are those whose electrical circuits constitute an integral part of the sound source. However, one must make a clarification here: electronic instruments contain active electrical components. Cf. Davies, *Electronic Instruments…*, p. 67.

120 Electrical devices rely on passive, i.e. non-transforming elements, such as resistors and capacitors. In addition to passive elements, electronic devices use active components capable of processing and amplifying electrical signals, such as vacuum tubes, transistors and diodes. Oscillators, employed in the quality of generators producing regular voltage fluctuations translatable into an acoustic signal, operate not on a mechanical, but rather on an electronical basis. The upright and electric player pianos are keyboard instruments that generate sounds acoustically – just like a traditional piano – and have acoustic building blocks: strings, hammers and soundboards. An electronic piano, however, is a fully electronic equivalent of a grand piano.

121 Curt Sachs, *The History of Musical Instruments*, translated by Stanisław Olędzki (Kraków: Polskie Wydawnictwo Muzyczne, 1989), pp. 422–423.

— e l e c t r o m a g n e t i c – in which magnets produce a magnetic field running through the cores of the transducer; used in turntables, headphones, microphones, electric guitars, and church organs;

— e l e c t r o s t a t i c – converting energy using an electrostatically interacting air capacitor (and therefore requiring an external power supply); such transducers were used in loudspeakers and in some electric pianos (including the *krakauer electrone* constructed in New York in 1938) and in chromatic timbales (*timbales électroniques*, invented in the early 1960s by Guy Siwinski), rarely found in our day;

— p i e z o e l e c t r i c – using the phenomenon of crystal piezoelectricity;[122] used in the 1970s and 1980s to amplify, among other things, the sound of acoustic guitars and violins. The amplification of sound is carried out by electroacoustic means: acoustic vibrations are converted into electrical vibrations, which are then amplified by a system of electric circuits and electron tubes, then transformed into sounds using a loudspeaker;[123]

— p h o t o e l e c t r i c i t y – reacting to changes to the intensity of the light stream reaching them, only employed more widely since the mid-1980s, e.g. in MIDI protocol control keyboards (such as Yamaha's Disklavier, as well as Bernard Szajner's laser harp, a futuristic design created in 1981).

1.2.2. Music from an automaton – automatophones and proto-electrophones

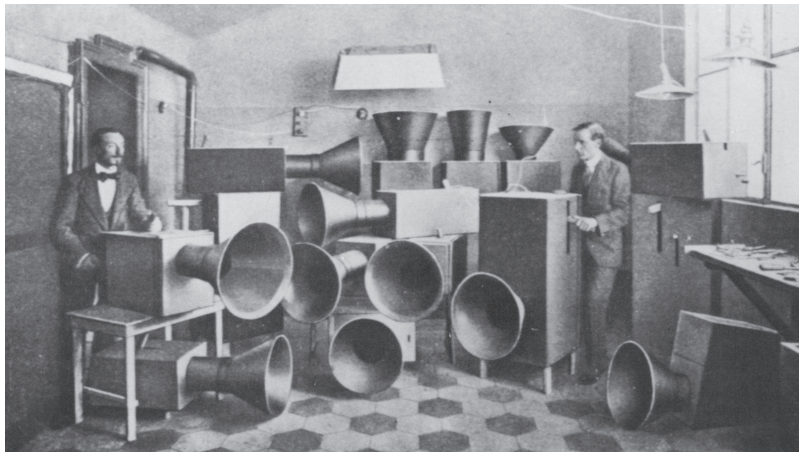
Before electric and electronic devices came into being, quite a few mechanical instruments driven by weights, springs and cranks were already in existence: simple musical toys, flute clocks, barrel organs, musical snuff boxes, singing bird toys, orchestrions, carillons, chimes, as well as the more complex organ automatons and player pianos. At the time, musical works were encoded on special media: from simple cylinders with nailed-on pegs, through discs with pins or

122 When a crystal, such as a quartz plate, is compressed, electrical charges appear on the side surfaces, proportional to the compressive force; in practice, the reverse effect, i.e. deformation of the wafer under the influence of an applied voltage, is employed as well.

123 The first electronic amplifiers were built in the mid-1920s; they were, however, not used in instruments until several years later. In the 1930s, several instruments for home use that could be connected to the radio, using its amplifier and speaker set, found their way onto the market.

holes, perforated or printed tapes, to the phonograph, the predecessor of the gramophone. Another invention that could be classified as automatophones were Luigi Russolo's intonarumori. This Italian futurist created music by organising noises and hums, which he would generate using a series of simple mechanical devices of his own construction. The first concerts featuring their use took place in Milan in 1914.[124]

A player piano (*autopiano*) is a kind of automatic piano that has an electromechanical or pneumatic mechanism for playing music recorded on perforated paper rolls or metal cylinders.[125] The first pneumatic piano players, as they were called at the time, appeared in the mid-19th century. The era of the player piano began in full with the Centennial Exposition in 1876, in Philadelphia (USA), which showcased several instruments of this type, including an electro-pneumatic design by the Schmoele brothers, as well as an automatic organ by John McTammany. Over the course of several decades, ever newer, more perfect and, simultaneously, more practical designs have managed to completely dominate the market for keyboard instruments in the United States.



Example 4. Luigi Russolo and Ugo Piatti with the *intonarumori*, Milan 1913

124 Dariusz Mazurowski, *Historia muzyki elektronicznej. Prapoczątki 1915–1945 [History of Electronic Music. The Origins, 1915–1945]*, *Muzyka 21*, 2010, issue 7–8, p. 56.

125 Such mechanisms were already known as far back as in the 18th century (musical jewellery boxes, music boxes, catharses, etc.).

The player piano was included in the line-up of a piece, *Ballet mécanique* (1924), for player pianos, xylophones, electric bells and the sound of an aeroplane propeller by one of the continuators of the Futurist idea, George Antheil. More than 50 pieces for *piano player* (Studies #1-#51) were composed between 1948 and 1992 by Conlon Nancarrow. At the dawn of the 21st century, Steffen Schleiermacher wrote *Four Pieces* for the prepared player piano (1999), *Geharnischt*! for 2 player pianos (2005) and *SiK2Cl2Mn* for the player piano (2009). Owing to electronic media, the perforated rolls were replaced by a computer system in *Hommage à RILEY – REICHlich verGLASSt* (2001) for the MIDI keyboard. One Polish piece representing this current is Krzysztof Meyer's *Les sons rayonnants* for 2 player pianos and a computer (2000).

The initial attempts to use electricity in instruments probably took place as early as the mid-18th century, the golden age of automatons.[126] The period includes *Denis d'or* (French for 'golden Dionysus') by Václav Prokop Diviš and *clavecin électrique* by Jean-Baptiste Delaborde.[127]

The technologies of the nineteenth century were dominated by electromagnetism. In 1850, John Mirand used the battery, magnet and coil invented by Alessandro Volta to create the first electric bell. In 1856, Hermann von Helmholtz initiated acoustic experiments with resonators and speech synthesis, among other items. The first electric instrument is considered to be the musical ('acoustic', 'harmonic' – as it was called) telegraph, built in 1874 in the United States by Elisha Gray, allowing the transmission of over ten frequency-differentiated tones. In the newer version, controlling the pitch of the sound generated became possible by connecting a two-octave keyboard.[128]

In 1897, Thaddeus Cahill patented the electric telharmonium, also known under the name 'Dynamophone', which was built only a few years later. This enormous, 200-tonne instrument has seen several practical realisations and attained considerable popularity[129]. The

126 Barbara Bogunia, *Ars combinatoria i mistyczne automatony [Ars Combinatoria and Mystical Automatons]*, *Glissando*, 2014, issue 23, p. 84.

127 Information on these instruments is very scarce and fragmentary. These designs most likely employed electrostatic charges as a sound source. See: *120 Years of Electronic Music*, http://120years.net/wordpress/clavecin-electrique-1759/.

128 Holmes, *Electronic and Experimental Music*…, p. 44.

129 Its experimental potential was emphasised by people like Feruccio Busoni in his 1907 manifesto, *Outline of a New Musical Aesthetic* (*Entwurf einer neuen Ästhetik der Tonkunst*).

solutions used in it were remarkably inspiring, as the instrument enabled reading sounds from a pre-prepared tape, not unlike a player piano. The sonic heart of the instrument was a set of disc-shaped rotors, with grooves of various types incised on their surfaces. These, in turn, rotated in a magnetic field, generating an electric current with characteristics corresponding to the harmonics.

The set of generators used in the telharmonium was employed in the choralcello – a hybrid acoustic-electric instrument patented in 1888, but not presented until 1909, much smaller and more practical in terms of size.[130] Not unlike the player piano, the choralcello was able to play music from a paper tape, so even then it was already possible to compose pieces that were difficult or even impossible for a human to play.

The idea of an acoustic-electric hybrid was taken up in 1931 by a company in Berlin, Carl Bechstein, which built the Neo-Bechstein, a piano featuring eighteen microphones in addition to the strings and soundboard, making it possible to obtain a much richer and longer-sustained sound, a more profound *crescendo* and a differentiation of timbre despite the instrument's small size. Between the wars, instruments with electromagnetic transducers (pianos, violins, cellos and others) were also built, but none of them, save for the guitar, took a prominent position in the practice of music.

One of the earliest applications of the electronic oscillator was William Duddell's 'singing arc', built in 1899. Demonstrating his simple invention at London's Institution of Electrical Engineers, Duddell connected a frequency-controller keyboard and, to the amazement of the audience, performed the British anthem, *God Save the Queen*. This event could be considered to have been one of the first performances of electronic music. Despite the lukewarm interest from musicians, Duddell's singing arc was the only fully electroacoustic instrument developed before the World War I, and its synthetic timbre was unlike anything heard by the human ear before.

The significant rise in popularity and rapid development of electrophones occurred in the era of widespread electrification, in the 1920s and 1930s, i.e. in parallel with the development of phonography, recording techniques and in the context of the cultural and industrial

130 In addition to the electromechanical system, it contained strings arranged in a vertical orientation, struck by hammers or moved electromagnetically. The choralcello featured two keyboards: one with 64 keys, triggering acoustic sounds, and one with 88 keys, controlling the acoustic and electronic parts at the same time, and – much like a traditional organ – pedals and switches.

boom of the 'Roaring Twenties'. As noted by Dariusz Mazurowski, more instruments were created at the time than works written for them.[131] This boom was halted by the outbreak of World War II, but, that notwithstanding, more than 500 patents related to musical instruments had been filed by 1950.

The history of instruments with electronic circuits began with the invention of the electron tube, i.e. as early as the beginning of the 20th century. First came John A. Fleming's diode (1904), and then the triode ('audion') invented by Lee de Forest (1906), a radio pioneer. These inventions enabled the practical application of a beat (known as heterodyning[132]), which de Forest exploited when he built the A u d i o n p i a n o . He built his first instrument in 1915, somewhat on the sidelines of other research work. Its design was based around a set of tube triodes generating regular current oscillations, one per octave, which allowed the instrument to sound several notes at the same time. The Audion piano's sonic quality was reminiscent of that of a violin or wind instrument. Although it neither entered into production nor musical practice, it initiated the development of electrophones of this type.

Based on the same working principle as the telharmonium was the popular electric organ, built in 1935 by Laurens Hammond from the USA. The sound produced by the instrument was warm and pleasant to the ear. An additional distinctive sound vibration effect was achieved owing to the use of rotating speakers ('Leslie Rotor'). Early versions had a separate console and executive section; later versions integrated them into a single unit. The Novachord, on the other hand, manufactured at the Hammond factory from 1938 onwards, boasted an unparalleled polyphony capability for its time – the 72 keys of the instrument could be sounded simultaneously. In a later, miniature version of the XE-1 organ, the electromagnetic generator was replaced by a digital one.

The Hammond organ was intended to replace the acoustic pipe organ. However, the genres where they attained the greatest popularity were film music[133] as well as jazz and rock music of the 1960s and 1970s,

131 Mazurowski, *Historia muzyki elektronicznej...*, *Muzyka 21*, 1915–1945, 2010, issue 9, p. 34.

132 Noam D. Pikelny, *Triode Vacuum Tube Laboratory Development*, University of Illinois at Urbana-Champaign, 2000, http://courses.physics.illinois.edu/phys406/NSF_REU_ Reports/2000_reu/Noam_REU.pdf.

133 The instrument was used, for instance, in the soundtrack of the 1939 film *Gone with the Wind*.

especially psychedelic rock, providing the distinctive sound qualities associated with this trend.[134] Their use in classical music was rare – the few exceptions include Karlheinz Stockhausen's *Mikrophonie II* from 1965.

Before World War II, the Hammond organ had little competition: in 1937, Harald Bode developed the Warbo Formant Orgel – a four-voice organ fitted with two filters and an envelope modifier, and, in 1940, he built the multimonica – a two-channel hybrid of an acoustic (harmony) and electronic instrument. In 1941, Constant Martin began work on the clavioline, imitating the sound of stringed instruments, launched (to no shortage of success) not long after the war.

Among the electrically-powered media for generating, storing and mixing sounds and music used in musical compositions were also the radio, phonograph, and gramophone.[135] The latter allowed 'locking' the sound in a loop, which became a very popular technique in the latter half of the 20th century (later on executed using magnetic tape loops, by Steve Reich, among others). Turntable loops are also used extensively in DJing practice.

1.2.3. From the light organ to graphic synthesis – optoelectrophones

The name 'optoelectrophones' encompasses not just audiovisual projection devices,[136] but also those in which light or images are used as carriers or transmitters – in other words, as graphic synthesis media. Light harpsichords and pianos were constructed as musical kaleidoscopes of sorts as early as the 18th century,[137] but it was only in the

134 In Poland, their userbase included Czesław Niemen and Andrzej Zieliński of Skaldowie.

135 The gramophone made its presence felt in musical works rather quickly, both as a playback device (e.g. in *Pini di Roma* from 1924 by Ottorino Respighi) and as an instrument (Stefan Wolpe). In the 1920s, Darius Milhaud, and later László Moholy-Nagy, began experimenting with vocal and instrumental recordings by changing the playback speed. In 1930, at the Musikfest Neue Musik at the Staatliche Hochschule für Musik in Berlin, Paul Hindemith presented three gramophone studies – *Grammophonplatteneigene Stücke* – while Ernst Toch presented *Fuge aus der Geographie*. At the same time, Edgard Varèse and Percy Grainger were experimenting with turntables in their own right, albeit independently of each other. Even after World War II, there were times when composers used these media in the quality of instruments, such as John Cage in his famous *Imaginary Landscape* series.

136 The *clavier à lumières* was based on a design by Alexander Scriabin, though not finished to completion, in 1915.

137 In 1725, Louis-Bertrand Castel created the *clavecin pour les yeux,* equipped with some 60 coloured luminous slides, revealed by pressing a key. In 1743,

20th century that the electric optophonic mechanism was developed. It was first invented and used by Vladimir Baranov-Rossine in his 1916 optophonic piano. His keyboard was coupled with a simple projector and controlled the light discs and, photoelectrically, the pitch of the sounds generated by the oscillators.[138]

Many similar instruments were created between the wars; suffice it to mention the Sarabet by American pianist and inventor Mary Hallock-Greenewalt (1918), the Chromopiano equipped with a projector of coloured 'light chords' by Arthur C. Vinageras (1921), or the light organ by Hungarian composer Alexander László (1925).[139] In the 1920s, successive and increasingly perfected versions of the Clavilux were presented by a Danish inventor, Thomas Wilfred, whose ambition was for the instrument to display not just coloured lights, but also less abstract and images that would go together well with the sounds. In the late 1920s and early 1930s, Ludwig Hirschfeld-Mack and Kurt Schwerdtfeger constructed the Farbenlichtspiel at the Weimar Bauhaus. Other attempts at this have been made since 1927, when Viennese architect Emerich Moses Spielmann built the superpiano. The keys of this instrument lit up lamps, whose light was then converted into electrical vibrations by a photocell. The superpiano was presented in 1929, but – as was the case with the other instruments mentioned above – without much success. When it came to sonic qualities, the instrument contributed nothing that could not be obtained using the already-popular non-contact electrophones available at the time.

The invention that enjoyed the greatest interest was the one designed in 1930 by Lev Termen, who, based on the theoretical assumptions of Henry Cowell, built the Rhythmicon – an optoelectric prototype of a drum machine. The instrument generated a regular sonic pulse as a result of the spinning motion of perforated discs through which a light beam passed, which in turn caused the activation of a heterodyne oscillator. The instrument's capabilities permitted the simultaneous run of 16 different rhythmic layers. In 1932, Cowell wrote several pieces for the instrument: *Rhythmicana,*

Johann Gottlob Krüger built a similar instrument, in 1816 David Brewster built his Kaleidoscope, and in 1877 Bainbridge Bishop patented the Color Organ. Cf. Louis M. Brill, *Light art across the centuries*, http://www.mediamachinations.com/sacreddestinations/light-art-across-centuries/.

138 The invention was lost to history, as the Jewish-born designer was murdered during World War II.

139 Davies, *Electrophone*…, p. 110.

Music for Violin and Rhythmicon and *Concerto* for Rhythmicon and orchestra. Unfortunately, the Rhythmicon had scarce sonic qualities and its role (as with the *intonarumori*) was limited to regular clattering, so it was more often used in acoustic and psychoacoustic studies than in musical works.[140]

The 1930s saw a decent number of innovative designs categorised as light organs.[141] The Saraga–Generator, built in 1931 by Volya Saraga, was distinguished by its use of a photoelectrically controlled vacuum tube made of light-sensitive cells and placed inside a box with small slits. A short distance away from this box, a neon lamp was placed, so that the performer's movements would interfere with the beam of light, causing changes of pitch over a span of four octaves. The timbre was controlled manually, and the volume was controlled using a foot pedal. It was one of the few optoelectrophones with performative potential – unfortunately, this never came to fruition.

In 1936, Frederick M. Sammis constructed an precursor of later samplers – a 'singing keyboard' for the film industry, which would play an audio track recorded on film tape. The instrument found use in recording soundtracks for cartoons. Another invention to appear at the same time (1936) was the *Lichttonorgel* – Edwin Welte's light organ fitted with a system of glass discs with acoustic waveform charts. The instrument offered full polyphony, as a separate optoelectric generator was assigned to each keyboard key. The light for exciting the current in the optical sensor was passed through a spinning disk with waveforms printed on it, corresponding to the fundamental tone and the first few aliquots of the sound frequency-wise. By intervening in the acoustic spectrum, the organ was able to generate different sounds, so it was, in a way, the first spectral instrument with a – as of then, not yet interactive – graphical interface.

The most important photoelectronic instrument turned out to be the ANS Synthesizer,[142] built in the late 1930s by Russian engineer, Yevgeny Murzin. It was based on the contemporary developments in the art of filmmaking.[143] The use of the original system of five

140 The first commercially distributed Wurlitzer-Sideman drum machine was only built much later, in 1959.

141 Derek Holzer, *A Brief History of Optical Synthesis*, http://www.umatic.nl/tonewheels_ historical.html.

142 The instrument's name is an acronym of Alexander Nikolaevich Scriabin.

143 The idea of graphic sound synthesis was pursued in a particular way by Canadian filmmaker Norman McLaren, who created soundtracks by drawing acoustic waveforms directly on film stock. This idea was employed in the works of Polish video-art artist, Józef Robakowski.



Example 5. A fragment of a glass disk with acoustic waveform patterns, used for graphic synthesis

fully printed (accommodating as many as 144 sound tracks) glass discs made it possible to fill the entire spectrum of human hearing (10 octaves, over 700 discrete pitches in total) – importantly, with the inclusion of microtones and unlimited polyphony. In addition, the ANS had an extensive control system, which offered the possibility to alter the sound material and have full control over the synthesis process. The role of data carrier and recording medium was fulfilled by what one may view as a kind of graphical score[144] – diagrams representing the spectrum and permitting independent control of all the sinusoidal generators, as well as their frequency spectrum. The ANS was used primarily by Russian composers, such as Alfred Schnittke (in *Stream* for synthesizer from 1969), Edison Denisow (in *Singing Birds* for synthesizer from 1969) and Sofia Gubajdulina (in *Vivente – Non vivente* for synthesizer from 1970). In line with its original purpose, the instrument was also used more extensively in film music: the ANS was used by people like Edward Artemyev for composing the soundtrack to the famous, award-winning Solaris (1972), directed by Andrei Tarkovsky.

The precursor of the digital electronic keyboards with pre-defined sound banks of our day was the Optigan – a polyphonic, electromechanical and optoelectric instrument produced since 1971. Essentially, it was an optical sampler offering the ability to mimic instruments, where the sounds were recorded on celluloid discs. In addition to being capable of imitating acoustic timbres, the Optigan was equipped with disks containing predefined sounds typical of synthesizers, percussion sounds, and rhythm patterns. It was one of the first of its kind to become popular for private use.

144 Similar principles for using graphic scores were later applied by Iannis Xenakis to UPIC computer systems during his work at the Centre d'Études de Mathématique et Automatique Musicales in Paris in 1977.

1.2.4. 'Music from thin air' – keyless and touchless electrophones

Between the wars, several keyboard-less electrophones were developed. One of these was the dynaphone, invented in 1927 by a French engineer, René Bertrand. The instrument took the form of a cylinder, 30 centimetres in diameter, in which pitch changes were made using a large knob. It also had additional mechanisms for adjusting articulation and timbre, as well as applying a vibration effect. The sound qualities of the instrument could thus imitate those of a violin or trumpet. The first public demonstration of the electrophone took place during a concert in 1928, with a performance of Ernest Fromaigeat's *Variations Caractéristique* for six dynaphones, composed specifically for the occasion, and Arthur Honegger's ballet, *Roses de métal*.

Similar capabilities to the dynaphone were presented by the Ondium, built by Henri C.R. Péchadre in 1930. This monophonic instrument shifted pitch by moving a special knob-indicator around the circumference of a calibrated dial. The volume was controlled by the strength and speed at which the keys were pressed. Ondium's six-octave ambitus did not prevent it from maintaining a small size. It was lightweight and easy to carry, so much that the performer could even keep it on his lap.

The electrophones of the inter-war period that one would deem to be the most innovative were contactless designs. They were operated spatially, usually using electromagnetic field properties. 'Music from the air' – this was the slogan used in the media to advertise these new, 'magical' instruments. Due to the appealing way in which they were played for the audience, most were intended to be played live, having – even then – the characteristics of a kind of audiovisual performance.

The t h e r e m i n, the most important and well-known of this group, was created somewhat by accident, on the sidelines of Lev Termen's work[145] at the St. Petersburg Institute of X-ray and Radiology. At that time, Termen constructed an oscillator – the first precision motion detector based on the phenomenon of heterodyning (rumble), which was also successfully employed as a source of sound. During his experimentation, Termen noticed that moving his hands around his device changed the pitch of the sound generated – the closer his

145 After having moved to the USA in 1927, he began using the name Leon Theremin. Although the creator originally called his work an 'etherophone', other names were adopted – 'thereminovox', or simply 'theremin'.

hands were to the antenna, the higher the pitch. Several years later, in 1924, he constructed an instrument with two antennae to respond to hand movements, based on his musical oscillator. To avoid the constant *legato* and *glissando* effects, the left hand operated the switch, and the dynamics were adjusted using a pedal.

The theremin was a monophonic and sonically limited instrument, but the ability to shape pitch through hand or body movements gave it an intuitiveness and flexibility hitherto unknown to performers. According to the builder's claims, the instrument could be mastered in a mere fortnight. 'If a 10 year old youth has the spirit of music in him, he can play the instrument in just two weeks – it would take a violinist two years of training'[146] – wrote the press, speculating at the same time whether the invention would still be able to persuade young people to practice laboriously on traditional instruments. The Theremin was, therefore, intended as an instrument 'for everyone'. And, indeed, commercially successful it was – probably the most successful of all the electrophones.

Even Termen's contemporaries, music makers and listeners alike, have embraced the instrument with great interest. In 1930, Termen also presented his instrument in the United States,[147] where he gave concerts with the New York Philharmonic Orchestra and gave a recital at Carnegie Hall (attracting considerable interest from prominent musical figures at the time: Sergei Rachmaninoff and Arturo Toscanini). When it comes to popular culture, it has been used by Charlie Chaplin, The Beatles and Jean Michel Jarre.

Seeing the versatile potential of his non-contact invention, Termen also built the Terpsitone (its name being a reference to the Greek muse of dance, Terpsichore), whose structural basis was a platform equipped with antennae sensitive to the movements of a dancer. Despite the novel idea, however, the instrument has not found practical application due to its complex and unpredictable controls (despite numerous presentations by theremin virtuoso Clara Rockmore). In the wake of the theremin's success, the stringless cello and the Illuminovox – an instrument which reacted to pitch changes with coloured lights – were created as well.

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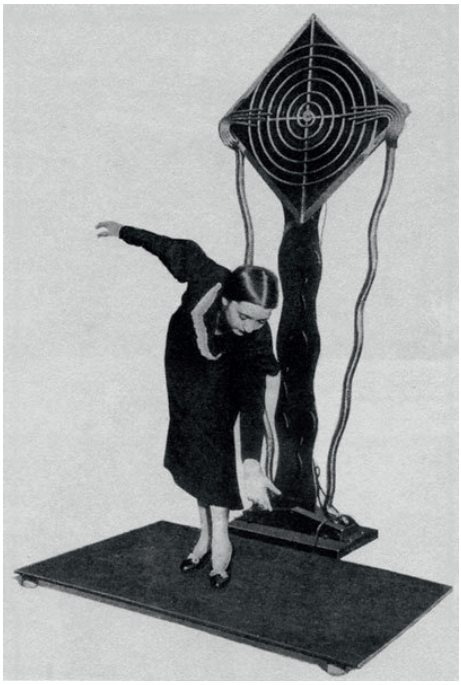
146 See: Albert Glinsky, *Theremin: Ether Music and Espionage* (Urbana: University of Illinois Press, 2000).

147 Towards the end of his life, Termen was dubbed the 'Soviet Faust', and widely regarded as a Russian spy. Cf. Danuta Gwizdalanka, *Sowiecki Faust [The Soviet Faust]*, *Tygodnik Powszechny*, 2010, issue 52, https://www.tygodnikpowszechny.pl/sowiecki-faust-144373.

The theremin's promising career in the United States was temporarily interrupted by the Great Depression at the dawn of the 1930s, and later by the global armed conflict. Following World War II, the teremin was used more frequently in film and popular music; its diabolical glissandos became an indispensable effect used in horror and science fiction films[148]. By contrast, it has not garnered much attention in classical music. Of the modest number of works, only *First Airphonic Suite* for theremin and orchestra (1929), *Melody* for theremin and piano, *Mouvement Electrique et Pathetique* for theremin and piano (1932) by Joseph Schillinger and *Fantasia* for theremin, oboe, piano and string quartet (1945) by Bohuslav Martinů are worth mentioning.



Example 6. Clara Rockmore playing the terpsitone

Most of the features of the theremin may be found, for example, in the *croix sonore* built in 1926 by Michel Billaudot and Pierre Dauvillier (based on Nikolai Obukhov's idea) and presented in 1934.

148 It was used in Alfred Hitchcock's 1945 film, *Spellbound,* and in *The Day the Earth Stood Still.*



Example 7. *Croix sonore*

The instrument's electronic apparatus is concealed inside a metal sphere, with a cross-shaped antenna mounted on top – hence the instrument's name and distinctive, futuristic appearance. In contrast, the *electronde*, built in 1927 and used by Martin Taubman, surpassed the theremin owing to its *staccato* capabilities.

At this time, the *sonar* was developed in Russia, distinguished by the use of a touch plate instead of an antenna, and Andrei Rimsky-Korsakov's *emiriton* – richer in sound, later also equipped with a quasi-keyboard. Ample possibilities of altering the sonic qualities were opened up by Andrei Volodin's ekvodin, constructed in 1937. Through the use of appropriate generators and filters, this monophonic electrophone was able to imitate the sonic qualities of several acoustic instruments. Similar possibilities were offered by the *elektronische Zaubergeige*, or 'electronic magic violin', constructed by Berlin radio personality Erich Zitzmann-Zirini (1927).

The non-contact instruments offered hitherto-unknown sonic qualities, despite being rather modest – additional external filtering and signal processing were rarely used. To be fair, most electrophones of the time sounded quite similar – they generated one or more superimposed pure tones. It may therefore be assumed that these instruments were considered appealing, more so by virtue of

their visual qualities. The concert took the form of a quasi-illusionist performance, designed to amaze the audience, with the aesthetic and musical impressions oftentimes being relegated to a secondary role.

Many composers and performers were of the persuasion that electrophones would change the face of 20th century music. Leopold Stokowski had an enthusiastic outlook on the future of an orchestra made up of thereminists, expecting it to 'open up a new era in music, just as modern building materials and technologies have created a new era in architecture, as one may already see by looking at skyscrapers'.[149] The most ardent proponent of electrophones was Edgard Varèse. In his 1936 manifesto, *The Liberation of Sound*, he embraced not just the rejection of the tonal system, but also the new electronic instrumentation. While in Paris in 1928, he collaborated with René Bertrand, the creator of the dynaphone, and following his return to the USA, he commissioned Termen to build a special model of the theremin with an extended frequency range, which he later used in the work *Ecuatorial* for 4 trumpets, 4 trombones, percussion, organ, piano and bass voice (1934), which, in retrospect, is considered the best and most valuable work for a theremin.

The vast majority of composers have not been able to fully exploit either the technological, sonic or performance potential of non-contact instruments. And yet, a fair number of these constructions could also be viewed as installations and sound sculptures of sorts. Paradoxically, it was transcriptions of classical works performed on the theremin that enjoyed the greatest popularity, where it was used like a traditional acoustic instrument. At the time, electrophones were treated not as signs heralding the arrival of a new aesthetic, but rather as technical innovations, 'futuristic', 'impossible', 'magical' instruments. However, it was an admiration devoid of any profound aesthetic reflection.

1.2.5. Towards the keyboard – the Trautonium and ribbon controllers

The popularity of the theremin has benefited other electrophones, most notably the *ondes Martenot* and the Trautonium. The latter took its name from its inventor, Friedrich Trautwein, a professor at the Rundfunkversuchstelle in Berlin. He built a monophonic electronic instrument using a wire stretched over a conductive metal strip in the

149 Source of the quote: Gwizdalanka, *Sowiecki Faust*...

place of a keyboard.[150] As a result, the coil transducer used in the theremin (creating a space sensitive to motion) was replaced by a ribbon transducer – which was, in turn, sensitive to touch. Pressing the wire closed the electrical circuit and caused the oscillator to start. By using a strip characterised by opportune resistance, the place of pressing directly affected the pitch.[151] This meant that the Trautonium could be played with a variety of forms of articulation, including *staccato*, *legato* or *portamento*. What's more, the instrument permitted a significant degree of alteration of the sound qualities of the generated waveform by adding both harmonics and non-harmonic aliquots.

The possibilities of Trautwein's instrument were first presented in Berlin in 1930; mere months later, the *Triostücke* for the Trautonium in the form of seven miniatures by Paul Hindemith premiered in the hall of the Berlin Conservatory. It was one of the first fully-fledged musical works intended solely for an electrophonic lineup. Moreover, the concert was held under the banner of 'electroacoustic music' (*elektroakustische Musik*), implying the arrival of a new musical trend. Hindemith contributed to the popularisation of the Trautonium on several more occasions, composing *Konzertstück* for the Trautonium and string orchestra in 1931, and *Langsames Stück und Rondo für Trautonium* in 1935. The instrument also appears in lineups of works by Richard Strauss, Carl Orff, Hans Werner Henze and Paul Dessau.

A lifelong virtuo so and the greatest populariser of the Trautonium was Oskar Sala – a co-performer of the works mentioned above and producer of the soundtrack to Alfred Hitchcock's famous film, *The Birds*. Sala also helped perfect it, owing to which, by the dawn of the 1950s Trautwein managed to develop a monochord, electronic bells, and a two-channel Mixtur-Trautonium, which, through the use of filters and by offering the ability to add sub-harmonic and non-harmonic tones, permitted one to modify the sound to a remarkable degree before the first synthesizers had even appeared.[152]

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150 The Trautonium only had a multi-octave keyboard added in its later versions.

151 An analogous principle entailing height change was used earlier in the Hellertion, built in 1929. Instead of a keyboard or multi-position switch, it had a touch-sensitive bar that changed the oscillator characteristics. In essence, the instrument was a prototype of a sensor resistor with variable resistance. The strip covered in leather, and its resistance was altered by applying finger pressure at various points along its length.

152 Some of the solutions found in the Trautonium were later implemented in complex modular synthesizers (e.g. subharmonic generators). Ribbon controllers have also been in use from the 1970s to the present day. The idea of a 'continuous keyboard' found its way into contemporary designs such as

The ondes Martenot were built in the late 1920s by Parisian cellist and composer Maurice Martenot. The prototype instrument bore clear similarities to the Theremin and was based – like most electronic instruments of the time – on tube oscillator technology. It consisted of a cord attached to a ring worn on the player's finger, which was used to control the sound using hand and body movements. The instrument was gradually improved: in 1929, it was fitted with a horizontal pitch control bar, situated below the keyboard (in early versions of the instrument, the keys were not tuned), the next version (1933) had a functional keyboard, and the next version had both, enabling both stepwise and smooth pitch change, vibrato, and *portamento*. Using switches and potentiometers, one was able to adjust the articulation, dynamics and timbre (volume envelope). In the late 1930s, the manufacture of models with quarter-tone keyboards started. In this form, the *ondes* managed to achieve a quick success (winning the Grand Prix at the Paris World Exhibition in 1937) and was accepted as an orchestral instrument.

In 1947, Martenot founded the *ondes Martenot* class at the Paris Conservatoire National Supérieur de Musique et de Danse. There were also many compositions created specifically for the instrument (by the end of the 20th century, more than seven hundred pieces had been written,[153] not counting its use in films and theatres). Composers creating music for the *ondes Martenot* included: Pierre Boulez, Edgard Varèse,[154] Olivier Messiaen, Giacinto Scelsi, Darius Milhaud, and Arthur Honegger.[155] One of the most convincing uses of the instrument was given by Messiaen in his monumental *Turangalîla-symphonie* (1946–1947). The *ondes Martenot* was considered by many to be the best and most practical electrophone developed before

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the *Continuum Fingerboard* or the *ROLI Seabord*, the latter being a keyless control keyboard developed by University of Illinois professor Lippold Haken and used by composers (John Williams) and rock musicians (e.g. Jordan Rudess of Dream Theater or John Paul Jones of Led Zeppelin).

153 Richard Orton, Hugh Davies, *Trautonium* [entry in:] *The New Grove Dictionary of Music and Musicians*, Vol. 25, ed. Stanley Sadie (New York-London: Oxford University Press, Macmillan), 2001, p. 704.

154 Varèse used the *ondes Martenot* in *Amériques* instead of sirens (1929).

155 See: Silvester Vicic, *The Ondes Martenot: a Survey of its Use in Selected French Compositions 1928–1950* [Master's thesis] (London: University of Western Ontario, 1984).

synthesizers.[156] As late as the 1970s, transistorised and, in the 1990s, digital versions of the instrument designed by Christian Deforeit were manufactured as well.

One instrument based on Martenot's design ideas was the o n d i - o l i n e built between the late 1930s and early 1940s by Georges Jenny. It offered greater possibilities of modifying the sonic qualities through the use of filters. It saw use especially in theatre, film and pop music, in particular in its more recent version, known as the *clavioline*. In contrast, the novelty of the univox constructed by Briton Les Hills was the ability to modify the waveform generated by the oscillator and the use of a pressure-sensitive, keyboard reminiscent of that of an accordion.

Frequency control in electrophones may be smooth – as in stringed instruments, or step-based – as on a keyboard. Over time, the latter solution has proved to be far more versatile. Thus, competition for the French designs came from the German inventions by J ö r g M a g e r: the quarter-tone electric organ (Viertelton-Harmonium) of 1912, the quarter-tone Kurbelsphäraphon[157] of 1923, the Klaviatursphäraphon of 1928 equipped with two single-voice keyboards, resonators and loudspeakers, or the four- and five-channel Partiturophon.[158] What's more, with the help of Darmstadt's authorities, in 1929, the inventor created his own laboratory, the Studiengesellschaft für elektroakustische Musik, which can be considered the first of its kind in the world. Unfortunately, no recordings have survived, therefore Mager's inventions and music were quickly forgotten.[159]

Even though there was no shortage of modern and inspiring ideas among the several hundred different electrophone models that were built in the first half of the 20th century, most of them did not play a significant role in the history of music. As noted by Dariusz

156 Thomas Bloch, *The Ondes Martenot*, *Experimental Musical Instruments* (1992), Vol. 8, issue 1, pp. 8–12.

157 A number of quarter-tone pieces were composed for this instrument by Georgy Rimsky-Korsakov.

158 It was used, among other things, in the staging of Wagner's *Parsifal* at the Bayreuth Festival in 1931.

159 Starting in the early 1930s, there was also a group of composers, directors and performers of electroacoustic music at the Heinrich-Hertz-Institut für Schwingungsforschung in Berlin, which still exists today. It was there that the first electrophonic ensemble was formed, made up of theremins, Trautoniums (operated by Oskar Sala), Bruno Helberger's Hellertion, as well as electric pianos and strings. Unfortunately, following Adolf Hitler's rise to power, the development and interest in electronic music and electrophones drastically declined on ideological grounds.



Example 8. Jörg Mager with his Sphäraphon

Mazurowski, the presence of these new sound media 'did not cause a change in the general approach of composers, who still preferred instrument-based reasoning. Despite the expansion of the sonic palette and means of composition and performance owed to electroacoustics, the aesthetic norms remained unchanged.'[160] Technology developed somewhat quicker than the arts, which were in turn not quite able to exploit the possibilities granted by the former – composers were not able to break free from centuries-old habits and traditional approaches, writing music for electronic instruments in the same way as they would for acoustic ones. The new technology also placed the audiences and critics in a difficult position, as they were not able to conjure up proper descriptions for the new phenomena. As they heard the electronic sounds for the first time, they sought associations with the sounds that they were already familiar with.

Even though the new genre eluded aesthetical sanctioning in the interwar period, attempts were made to describe and define it. Only a handful of composers have been able to understand and exploit the potential of the electrophones; they included: Edgard Varèse (who

160 Mazurowski, *Historia muzyki elektronicznej…*, p. 55.

attempted to set up an opportunely-equipped studio on a couple of occasions), or the lesser-known Carlos Chávez, the author of *Toward a New Music: Music and Electricity* (1937).[161] This work adopted an innovative theoretical and research perspective. It includes descriptions of new musical media, including electric instruments, as well as 'sound photography' and 'electric photography'. Chávez, a pioneer of the field of electroacoustic music theory, predicted the arrival of a time when artists would be able to use new media in a more direct way, without the aid of technical intermediaries, which would in turn pave the way for the arrival of new art forms.[162] The full utilisation of electronic instrumentation requires a completely new compositional language and entirely new techniques – a new way of working. This was also well understood by John Cage, who, as early as 1937, predicted in his *Future of Music: credo*[163] that the future of music lay in specialised recording studios. His predictions came true right after the war.

1.2.6. From the studio to the stage – the first synthesizers

After 1945, music employing electronic media became part of the artistic avant-garde. It took on forms that were entirely new in terms of performance, form and structure, and sound alike – which, in turn, led to the development of new instruments. At times, musical applications were found for items whose origins were oftentimes not musical at all, such as laboratory equipment, telecommunications equipment, etc. Some have completely lost their original purpose, becoming tools used strictly for making music (e.g. the vocoder[164]).

Making artificially generated sounds necessitated the use of devices capable of sound synthesis – synthesizers. The first, though not entirely successful attempts to create such an instrument were made by Harry Olson and Herbert Belar at RCA Princeton

161 See: Carlos Chávez, *Toward a New Music: Music and Electricity*, translated into English by Herbert Weinstock (New York: Da Capo Press, 1975).

162 Manuel Rocha Iturbide, *The First Retrospective of Mexican Electroacustic Music,* http:// www.artesonoro.net/articulos/Electroacusticinmexico.pdf.

163 See: http://www.arts.rpi.edu/~century/MMC11/JohnCage_Silence.pdf.

164 A vocoder is a kind of speech synthesizer. A pioneering device in this category, the *Vo der,* built by Homer Dudley at Bell Laboratories, found applications in communications, including on the frontlines of World War II. See: Craig Anderton, *How Vocoders Work*, http://www.paia.com/ProdArticles/vocodwrk.htm.

Laboratories, who (not unlike Raymond Scott earlier[165]) aimed to create a mechanism for 'generating popular music'. Following a partial modification of the initial premises in 1957, they managed to build two tube devices, equipped with 12 and 24 oscillators, respectively. They were programmed using a perforated paper tape, not unlike in the case of a computer.[166] They were named Mk I and Mk II (RCA Mark II). Quickly enough, these came into use by composers gathered around the Electronic Music Centre at Columbia-Princeton – the first studio of its kind in the United States. Mk II was successfully employed by Milton Babbitt in his serial compositions (including 1961's *Composition for Synthesizer* and 1964's *Philomel*). It permitted the creation of a track layer by layer, and the modification of the sound generated by affecting its envelope, spectrum, adding *portamento* and *glissando*, changing registers, filtering, mixing, etc. In later versions, it was also fitted with a microphone, owing to which it could act as a simple sampler.

A new phase in the development of synthesizers began in the 1960s, heralded by the invention of the transistor. In 1963, the industry market was conquered by an instrument designed by Robert Moog,[167] in collaboration with composer Herbert Deutsch and Wendy Carlos. This synthesizer was a monophonic instrument, but its design was modular, i.e. it permitted expansion by attaching further modules. It featured a keyboard integrated with a control panel (with buttons, potentiometers, etc.), which allowed its use for concerts, and not merely – as was the case with earlier synthesizers with numerical control – for studio work. The first instruments of this type were monophonic, but the rapid advances in the miniaturisation of electronic circuits, as well as the development of integrated circuits, enabled polyphony and the miniaturisation of the instruments themselves.[168] Robert Moog himself continued to expand his synthesizer, creating several models, including the polyphonic polymoog and the

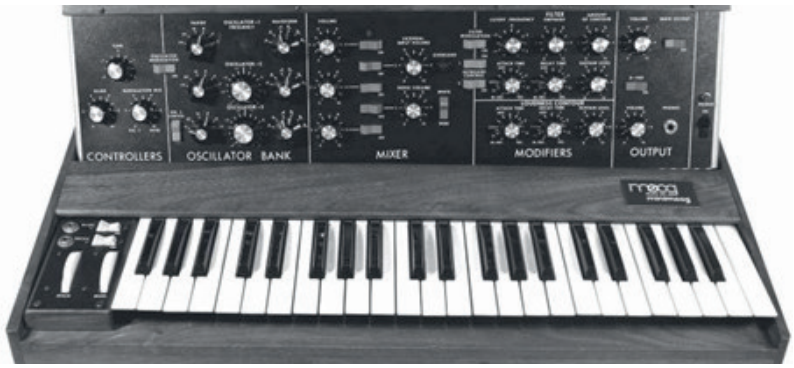
165 Raymond Scott is best known for his collaboration on 1940s animated films (*Looney Tunes* and *Merrie Melodies*), for which he created the soundtracks. In 1956 – almost a decade before Robert Moog did – he designed and built a simple keyboard synthesizer.

166 The perforated tape contained pitch, volume, duration and timbre data. The instrument used a traditional, tempered chromatic scale.

167 Robert Moog constructed and sold theremins, and, in 1961, began working on a transistorised version of modular synthesis.

168 In 1963 and 1964, two products developed by Donald Buchla, as well as the first portable synthesizer developed by Paolo Ketoff Synket found they way onto the market.

miniaturised minimoog.[169] They attracted widespread interest from creators and performers of various musical currents – especially popular music.[170] Synthesizers began to replace certain instruments in musical ensembles: bass synthesizers, drum machines, and sequencers, employed mostly in dance music, were also produced.[171]



Example 9. Minimoog

At the same time as the popular moog, the mellotron came into being, made in 1963 by the British company Streetly Electronics. The new solutions implemented in the instrument made it possible to simulate the timbres of acoustic instruments while creating a design that was just as practical as possible. The Mellotron was equipped with a keyboard coupled to a magnetic tape player, and pressing a key would result in selecting and playing a pre-prepared recording.[172] This

169 Trevor J. Pinch, Frank Trocco, *Analog Days: The Invention and Impact of the Moog Synthesizer* (Cambridge: Harvard University Press, 2004).

170 Minimoog was the first portable, widely-used synthesizer. It was used also for the creation of albums by pop-rock bands (e.g. The Beatles, The Rolling Stones), as well as for jazz (Patrick Gleeson, Herbie Hancock). It also owes its rapid rise to popularity to the release of synthesizer interpretations of popular Bach works (*Switched on Bach*). The first Polish musician to use synthesizers was Czesław Niemen.

171 It should be emphasised that 'high-brow' music constantly and abundantly drew on the technical developments emerging in the field of pop culture. Looking at the 20th century from the broadest perspective, Moog's inventions and the electric guitar seem to be more important than the theremin or *ondes Martenot*.

172 At that time, storing sounds proved to be a technological problem. Electroacoustic methods (using shellac or vinyl discs) were abandoned in favour of electro-mechanical methods (using magnetic tape, optical film track) and, following the digital revolution, electronic methods (using special memory cards or cartridges, floppy disks, or hard drives).

analogue sampler – a device for mimicking acoustic instruments, while simultaneously exceeding their technical capabilities – allowed monophonic instruments to simulate polyphony and keyboard instruments to simulate *glissando*, made it possible to exceed tonal ranges and to apply any dynamics in any register, and much more. What is more, it permitted the processing and playback of longer phrases, or even entire songs.

1.2.7. Modular meta-instruments – digital electrophones

In the 1960s and early 1970s, analogue technology reigned supreme.[173] When it came to synthesizers and other electrophones, the revolution came in the form of the microprocessor, which opened up the era of digital sound, i.e. sound generated using electronic components or by means of the digital synthesis (including resynthesis) of sound samples. Analogue circuits were replaced by digital processors: generators, oscillators, and modulators.[174] The synthesizer turned into a specialised computer.

Digital converters and devices are far superior to their analogue peers in almost every respect: they are more efficient, faster, smaller and cheaper. Digital technology developed (and keeps developing) much faster than analogue technology; it permitted compositional and technical solutions that are not possible in the analogue domain.[175] In our day, analogue pickups and instruments are used exclusively for their particular, warm sound.[176]

The dynamically-growing instrument market encouraged instrument builders to implement ever newer technical solutions and to specialise the equipment produced. Thus, several groups of instruments came into being:

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173 Back in 1974, the WDR radio studio in Cologne purchased an analogue synthesizer, the EMS Synthi 100, which was soon used by people like Karlheinz Stockhausen in his *Sirius* (1975–1977).

174 When it comes to digital sound, it is not the sound signal that is processed, but rather the corresponding numerical sequence.

175 Certain kinds of synthesis, such as sampling or additive synthesis, were only practically possible in the digital domain.

176 Analogue synthesizers (Korg Polysix, Synthi AKS, Yamaha CS-15, Byfacord B1, Roland TR-505) are used in improvisatory performances bordering between popular music and free jazz by experimental ensembles, such as Automatic Pilot, Go-Go Beuys-Band, Freight Train, featuring people like Krzysztof Knittel and Marek Chołoniewski.

— keyboard controllers – keyboard music interfaces of sorts, without no sounds inherent to them; their task is to control another electronic instrument (sound module), usually via the MIDI standard;
— keyboardless sound modules – they permit playing and modelling sounds; they come both in hardware and software (virtual) versions, usually combined with a control unit, such as a keyboard or wind controller;
— synthesizers – usually combining features of the previous two; sometimes, the term is used to describe any electronic instruments permitting the synthesis of sound; they have a modular structure, included sound samples, generators, filters, modulators, resonators, effect processors, etc;
— samplers – they permit the recording and modification of sound samples (known as sampling), and, when fitted with a keyboard, samples may be assigned to individual keys;
— keyboards – they permit the use of pre-recorded sounds, but without altering them; they usually focus on imitating the sounds of acoustic instruments, and sometimes have an automatic accompaniment functionality, which allows even amateurs to play effectively;
— workstations – combining the capabilities of all the aforementioned instruments, they allow composing and performing pieces without the need to work on multiple separate devices.

All of the above-mentioned instrument types find a wide range of uses in the musical arts, in compositional and studio work as well as performance alike. The most important and interesting of these, however, are synthesizers and workstations, which, owing to their rich possibilities, deserve to be called multi- or meta-instruments. Using them, one may not only play, but also shape new sounds and – directly – compose new music.

The transfer of information and reciprocal control of various electronic media – modules, synthesizers, sequencers, computers, and digital keyboards – was made possible in the early 1980s, by the development of the MIDI (Musical Instruments Digital Interface)[177] system, which fulfils the role of interface, software and a set of commands, the protocol. The data of this protocol contains information similar to that present in musical notation; it is a computerised musical notation

177 See: Roads, *The Computer Music Tutorial*…, p. 975.

of sorts.[178] A distinct advantage of MIDI is the ability to easily record the musical passages performed (up to a dozen layers) and play the recorded sequences back.[179] This permitted the development of effective sequencers for controlling synthesizers and modules. The first virtual software sequencers employing MIDI interfaces appeared in the mid-1980s on Apple personal computers, as well as those by Atari, more popular in Europe.[180]

The role of the first experimental digital synthesizers was fulfilled by computers, which were initially used mainly for various academic studies. The first polyphonic sampling digital synthesizer to feature a keyboard was the Fairlight CMI, built in 1978. At the same time, the Synclavier II, based on a newer method of sound synthesis, found its way to the market. 1983, in turn, saw the launch of the compact Yamaha DX7, which became the most popular and best-selling synthesizer of all time.



Example 10. Yamaha DX7

Another sampling synthesizer, the Emulator, introduced in 1982 by E-mu Systems, did not exceed the capabilities of its predecessors, but maintained competitivity due to its lower price. These instruments were purchased for experimental studios, but were used more extensively by the creators and performers of popular music. From the musician's point of view, the most important feature of such electrophones was their ability to easily modify the instrument's sound.

178 Russ Haines, *Cyfrowe przetwarzanie dźwięku [Digital Audio]*, translated by Marek Korbecki (Warszawa: Mikom, 2002), p. 215.

179 Most MIDI devices have a basic set of pre-loaded sounds – the General MIDI standard. However, the said sounds are too artificial for the current possibilities of sound synthesis and are rarely ever used in professional music.

180 Until the end of the 20th century, the most popular computer used as a MIDI sequencer in Poland was the Atari ST. This hardware platform saw the development of many pieces of professional software.

The spread of faster microprocessors and digital signal processors in the 1980s allowed the bolder use of new synthesis methods.[181] In 1987, Roland introduced the D-50, based on short sample banks and digital oscillators.[182] Owing to this, it became possible to not just utilise and modify high-quality samples of acoustic sounds, but also to synthesise them, as well as to create dynamic timbres that radically changed over time as they reverberated. Starting then, electrophones became even more versatile – capable of both faithfully imitating traditional sounds and composing entirely new ones.

The addition of a sequencer to the synthesizer constituted a breakthrough in the field of digital instruments, allowing multitrack recording and playback of not just samples, but also longer runs – even whole pieces.[183] This is how the most elaborate and versatile electrophones, workstations, were developed: they are 'multisynthesizers' with modules used for various methods of sound synthesis. One of the first, and best-known, examples of this type of instrument was the Korg M1, built in 1988. These devices were user-friendly, featured a keyboard and programmable buttons, switches, sliders, infrared controllers and, as more time passed, even wind controllers were added.[184]

Compact keyboard synthesizers had a radical impact on the performance and styling of all types of music.[185] These instruments, however, are now being replaced by computers. Developing hardware devices necessitates considerable costs, therefore research has partly moved into the field of software – virtual devices.

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181 For more on sound synthesis, see Chapter 2.2.

182 This method was dubbed *Linear Arithmetic Synthesis*. It permits the use of different sound samples in successive phases of the volume envelope.

183 In 1984, before MIDI was even developed, Barry Vercoe composed *Synapse II* for flute and computer – the first piece with automatic accompaniment. A year later, Morton Subotnick and Mark Coniglio created Interactor – a piece of software capable of tracking performance. In 1986, David Zicarelli completed his work on Jam Factory – a piece of software using MIDI to analyse musical data and 'improvise' further layers of sound based on it.

184 Wind controllers were used in electrophones as early as the 1920s (*Lyricon, Variophon, Tromborad, Electra Melodica*). The most popular instrument of this type was the melodica, a wind instrument similar in construction and timbre to the mouth organ, featuring dozens of keys. It was first used by Steve Reich in his 1966 piece, *Melodica*.

185 This was especially evident in the 1970s and 1980s, when almost all genres of popular music and jazz were taken over by electronic instruments and sounds.

1.2.8. Virtual electrophones – synthesizers and software environments

In the 1990s, digital synthesizers were integrated into computers, including personal computers. The increasing computing power of these devices made it possible to effectively simulate various hardware synthesizers; it also made permitted using graphical interfaces for improving the work with the virtual instrument. They enabled easy and intuitive operation, i.e. direct control of sound parameters.

At that time, equipment enabling virtual analogue modelling emerged. This was possible because high-speed microprocessors had enabled the effective simulation of analogue acoustic waveforms, volume envelope modulators, filters, and low-frequency oscillation (LFOs).[186] As computer sound cards were supplied with more powerful signal processors, the creation of new virtual instruments followed. The role of synthesizers, samplers and sequencers was taken over by a computer with software based on digital sound processing, employing different types of synthesis. In 1996, Steinberg Media Technologies established a standard for virtual instruments and additional modules for extending their capabilities, which was quickly adopted by the entire market – the VST (*Virtual Studio Technology*)[187] plug-ins. This technology made it easier for software developers to create new software-based synthesizers and studio effects. They usually come with own, integrated GUI and MIDI interfaces, owing to which they may be controlled in real time with the use of external controllers.[188]

The origins of visual interactive music programming environments may be traced back to the 1980s, when Miller Puckette, then employed at IRCAM,[189] developed a visual programming language and environment designed for audio processing, creating the first

186 One of the first examples of such an instrument was the 1995 Clavia Nord Lead.

187 A new version of the specification, VST 2.0, was introduced in 1999, and VST 3 was introduced in 2006.

188 In our day, software such as Cubase, Nuendo, Ableton Live, Reaper or FL Studio became widespread, allowing VST plug-ins to be run in other environments.

189 At that time, IRCAM became the most important research centre for electronic music. The first fruit of its work to influence the world of art music was the Sogitec 4X computer system, offering real-time digital sound processing. It was used by people like Pierre Boulez in his 1981 work, *Répons* for 24 musicians and six soloists whose playing was subjected to electronic processing.

version of the Max software.[190] The said software was originally intended to be used for MIDI control,[191] but its versatile potential was quickly developed in other directions: algorithmic composition and the creation of interactive sound systems. In 1990, Max was released commercially, and new versions were both created and developed. A significant extension of the software was the addition of the MSP module,[192] which enabled real-time sound manipulation and allowed users to create their own synthesizers and effect processors. Max/MSP, therefore, offered the possibility of operating in two different modes: event scheduling and live signal processing.

The Max language and environment enable the creation of programs (called patches or patchers) built by block-linking interactive virtual objects – self-contained mini-programs that process the data of generators, envelopes, analysers, switches, buttons, etc., symbolised graphically.[193] The order of the action execution system – the path of data and signal flow – maps the layout of objects and the manner in which they are connected. It becomes a musical score of sorts, one which connoisseurs are able to read intuitively, just as one would 'read' the score of works composed traditionally.

MAX has become the most popular 'instrument' used for electroacoustic composition: in live electronics, installations and performances, and live performances (used by most Polish composers). The software became even more versatile at the dawn of the 21st century, when an external video module was added: first *nato.0 55* (1999), then *SoftVNS,* developed by Canadian artist David Rokeby (2002) and finally *Jitter,* enabling real-time and 3D operation (2003). It was then when the software attained recognition among multimedia artists.

In 1996, Puckette released a revised (and, more importantly for users, free) version of the original Max development environment, under the name *Pd* (Pure Data). Similar software soon followed,

190 Max is named after a pioneer of digital synthesis and computer music, Max Mathews.

191 It was first used by Philippe Manoury, in his work *Pluto* for piano and computer (1988).

192 MSP is an initialism for *Max Signal Processing*, as well as also the initials of Miller S. Puckette.

193 At present, Max/MSP features around 600 different objects. They are able to carry out a variety of mathematical and logical operations: from the simplest echo and reverberation effects to complex three-dimensional animations, rendered in real time. For instance, the *metro* object is a metronome, *random* is a pseudo-random number generator.

including SuperCollider.[194] They are suitable both for the algorithmic creation of melodic, rhythmic and timbral sequences, and for controlling a variety of peripherals – they are interactive meta-instruments.[195] They are versatile tools for generating, analysing, synthesising and processing data, whose output may take the form of sounds, images or video material. The broad possibilities of similar software are also a testament to the creative freedom granted to composers by new media.

With the increase of the popularity and availability of interactive computer technology, it became possible to perform music using means previously unknown to the musical tradition.[196] At the same time, the software – as virtual environments – became a more convenient alternative to hardware-based instruments, effects and musical devices. Owing to this, a pluralisation of musical creativity of sorts took place, leading to an increase in home and 'garage' composing, as well as making one's music available via the web. At the same time, the image of a composer-turned-informatician, well versed in the latest computer technologies and engaged in programming for his own use, came into being.[197]

When in comes to digital instruments, the interactive and multimedia potential is being radically expanded. Their hybrid, modular nature permits the construction of a variety of configurations and audiovisual systems. Such structures may include sensors (accelerometers, proximity sensors, light sensors), multimedia displays or projectors, extensive sound systems, and similar. Indeed, owing to new media, the art of music has reached the point where any kind of data – vibration, pressure, movement, light, acceleration – can be

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194 SuperCollider is an environment and programming language created in 1996 by James McCartney, designed for audio synthesis, algorithmic composition carried out in real time, as well as interactive programming.

195 Owing to amplification and effects processors, anything that produces sound – even inaudible to humans – has the potential to become an instrument. For instance, in Wojciech Błażejczyk's *Trash music for instrumental ensemble*, objectophones, voice and live electronics (2013), the instruments used are everyday objects, including a hairdryer, a typewriter, a fragment of a gas cooker, an egg shredder, bowls and lids. The composer used them to generate sounds, and then mixed them with instrumental parts.

196 E.g. *laptronica*, where the line-up is made up of laptops or engages in *live coding*, that is, live music programming.

197 Since 2002, the New Interfaces for Musical Expression (NIME) conference, dedicated to the scientific study of the development of new musical technologies, is organised in various cities around the world. The conference includes presentations of instruments and sound interfaces.

translated into sound. Any physical object can become a means of control, as its 'parameters' may be represented numerically, allowing digital devices to be controlled. In other words, owing to new media, everything can act as a musical instrument.

1.3. Electroacoustic music – new trends and genres

Not unlike the evolution of instruments and compositional techniques, the development of musical forms and genres followed not just the aesthetic changes in the arts, but the expansion of technology as well. The ability to record and reproduce sound signals gave rise to *musique concrète*, oscillators and generators enabled synthesising sounds and creating electronic works, the development of algorithmics and computer science gave rise to computer music, and so on. Alongside these currents, new terminology was making its way into the world of sound arts as well. In the latter half of the 20th century, one would encounter a variety of terms, no longer in use today, such as 'electron music' (equivalent to *elektronische Musik*) or 'experimental music' (associated with the activities of experimental studios). Even in the present day, terms as common as 'electronic music' or 'computer music' are sometimes interpreted differently than they used to be originally. This chapter will aim to redefine and outline the scope of these concepts as precisely as possible.

In the present day, the term 'electroacoustic music' seems to be the most universal,[198] superseding the term 'electronic' popularised by, among others, Włodzimierz Kotoński.[199] According to *The New Grove Dictionary of Music and Musicians*, electroacoustic music is music in which electronic technologies are used for the generation, exploration or 'configuration' of sound material, and in which loudspeakers (in the capacity of electroacoustic transducers) are the primary medium

198 The term 'electroacoustic music' came into use in the 1950s, but for some time the terms 'electronic' and 'electroacoustic' were still treated almost synonymously. In the present day, it makes little sense to artificially maintain the division between electronic and electroacoustic music, as it is not always possible to grasp the difference between concrete and synthetic material in a concert setting. Cf. Bohdan Mazurek, *Materiał dźwiękowy w muzyce elektronicznej i technologiczne metody kształtowania [Sound Material in Electronic Music and Electronic Shaping Methods]* [in:] *Technologia muzyki elektronicznej [The Technology of Electronic Music]*, eds. Bogusław Schaeffer, Teresa Chylińska, *Forum Musicum*, issue 6 (Kraków: Polskie Wydawnictwo Muzyczne, 1969), p. 4.

199 Kotoński, *Muzyka elektroniczna*...; The author pointed out that the term 'electroacoustic' is not very popular for linguistic reasons.

of acoustic transmission.[200] The term is thus very broad and allows one to cover a wide variety of phenomena related to this kind of musical works; it emphasises the use of electronics without referring to a historical period, aesthetic or style.

A sizable number of theoretical works comprehensively covering the history of electroacoustic music exists. When it comes to Polish musicology, the most comprehensive one is the first part of Kotoński's *Electronic Music*. The author focuses on putting concepts, genres, facts and dates in due order. However, since the work was written in the 1980s, it presents a viewpoint that is no longer valid. The author gave little attention to digital technologies, which at the time were poorly disseminated in Poland: 'by 1985, when we are writing these words, computer music is virtually non-existent in Poland'[201] – stated Kotoński. The only publication to comprehensively cover the history of electroacoustic music in Poland is the text by Mieczysław Kominek.[202] Therefore, this chapter will, on the one hand, aim to fill in the gaps and, on the other, to present the historical facts in a broader context, with a particular focus on Polish art.

1.3.1. Collages of sonic photographs – *musique concrète*

Musique concrète is, simply put, composing using recorded sounds. These can be recorded vocal parts, instrumental parts, sounds of nature or machinery. The technological wherewithal of composers of *musique concrète* was already taking shape before World War II, and was primarily based on the newly developed electrophones and, more significantly, techniques associated with the radio.[203] The success of this type of broadcast lay, above everything else, in perfect production: the producers used the entire known gamut of electroacoustic means

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200 Simon Emmerson, Denis Smalley, *Electro-acoustic music* (entry) [in:] *The New Grove Dictionary of Music and Musicians*, Vol. 8…, p. 59–67.

201 Kotoński, *Muzyka elektroniczna*…, p. 64.

202 Kominek, *Muzyka elektroakustyczna w Polsce*...; The first Polish electroacoustic works are the object of the text by Marek Zwyrzykowski, *Początki muzyki elektroakustycznej w Polsce [The Beginnings of Electroacoustic Music in Poland]*, http://pseme.com/.

203 One of the most popular radio theatres of the 1930s was Orson Welles' The Mercury Theatre on the Air, initiated in 1937 at a New York radio station. This theatre performed Bram Stoker's *Dracula* in 1938 and, most famously, *The War of the Worlds* in the form of fictional reports of an alleged Martian invasion. The radio play, its sound illusions, has proven to be so evocative and realistic that more than a million people took the events for real, succumbing to widespread panic.

of the time.[204] At the same time, Egyptian composer Halim El-Dabh, then a student at Cairo University, began experimenting with wire recording. He recorded the sounds accompanying the ancient *zaar* ritual and processed them in the radio studio, adding, among other things, reverberation and echo effects. He called his piece *The Ta'abir Al-Zaar* and presented it in 1944 in Cairo.[205] This work may be considered a pioneering one, although, in the years that followed, it was the Parisian community, whose main representatives were the radio sound engineer, Pierre Schaeffer, and the composer, Pierre Henry, that became particularly associated with the *musique concrète* trend. Their studio experiments of the late 1940s and early 1950s laid the foundations for what would later become the most important new type of music of the second half of the 20th century – electroacoustic art.

Schaeffer began working at the Studio d'Essai de la Radiodiffusion Nationale in the early 1940s. There, he encountered techniques for recording radio plays and radio operas,[206] and was also inspired by the forms of editing used in cinematography.[207] In 1948, Schaeffer began his 'research into noises',[208] resulting in a composition for the phonograph *Five Bruitist Études* (*Cinq études de bruits*[209]), presented on Paris radio at the end of 1948. In 1949,[210] Schaeffer was joined by Henry. A fruit of their collaboration was the *Symphony for a Lonely Man* (*Symphonie pour un homme seul*) – their most important work of this period, created still without the use of magnetic tape. This is when the term *musique concrète* came into use. The word *concrète*,

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204 Even then, the potential for creating music based on recordings was noticed by Henry Cowell and Igor Stravinsky. See: Dariusz Mazurowski, *Historia muzyki elektronicznej Prapoczątki 1915–1945: Radio [History of Electronic Music. The Beginnings, 1915–1945: the Radio]*, *Muzyka 21*, 2011, issue 8, p. 34.

205 During the 1950s and 1960s, he was active at the Columbia-Princeton Electronic Music Center, See Denise A. Seachrist, *The Musical World of Halim El-Dabh* (Kent State University Press, 2003), p. 91.

206 John Dack, *Pierre Schaeffer and the Significance of Radiophonic Art*, *Contemporary Music Review* (1994), Vol. 10, issue 2, pp. 3–11.

207 His research and extensive knowledge, which he put into practice in the following years, were confirmed in published texts, notably *À la recherche d'une musique concrète* (Paris: Éditions du Seuil, 1952) and the article *L'objet musical*, *La Revue Musicale* (1952), issue 212, pp. 65–76.

208 Carlos Palombini, *Machine Songs V: Pierre Schaeffer – From Research into Noises to Experimental Music*, *Computer Music Journal* (1993), Vol. 17, issue 3, p. 4.

209 *Étude aux chemins de fer* (sounds of trains); *Étude aux tourniquets* (sounds of toys and percussion), *Étude violette*; *Étude noire* (Pierre Boulez playing the piano); *Étude pathétique* (sounds of kitchen utensils, singing, speech).

210 Palombini, *Machine Songs V.…*, p. 4.

was intended to refer to the situation of a composer working on sound material directly, as opposed to traditional composition, based on abstract work with notation. The extra-instrumental material – the 'sound object' (*objet sonore*), as Schaeffer called it – would be, through the recording of an ephemeral, auditory sensation, 'transformed into a concrete entity with the characteristics of an object, which only in this form could be useful for compositional work'.[211] The transformation of these sound objects was intended to 'strip them of their anecdotal sense'.[212] So it was not only a technological breakthrough, but also a psychological one,[213] as concrete sound was placed in opposition to abstract sound. In instrumental music, the 'sound object' is the end result; in *musique concrète*, one starts with the 'sound object', and the material itself somewhat precedes the structure of the work.

The reverse process of composing *musique concrète* was not based on shaping the traditional elements – melody, harmony or rhythm – but on collecting recordings and abstracting their musical qualities.[214] Metricality and rhythm notation became redundant – the temporal range became directly reflected in the length of the tape. Instrumental structures were, in a certain sense, reinterpreted: the effect of harmonic and melodic successions was considerably weakened, bringing to the fore the special character of the timbre of a single sound – the sonic quality.[215] However, according to Pierre Henry, *musique concrète* was not based on the mere exploration of sound itself, but, above everything else, on its shape and form, on the 'sculpting' of recordings.[216]

As early as 1951, Abraham Moles and Pierre Schaeffer published aesthetic texts on *musique concrète*, emphasising its virtues, such as the permanence of recordings, the possibility of reproducing it

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211 Mazurek, *Materiał dźwiękowy w muzyce elektronicznej…*, p. 6.

212 Józef Patkowski, *Kompozytor a technika studia muzyki eksperymentalnej [The Composer and the Technology of the Experimental Music Studio]* [in:] *Horyzonty muzyki*, issue 40 (Kraków: Polskie Wydawnictwo Muzyczne, 1970), p. 3.

213 Holmes, *Electronic and Experimental Music…*, p. 78.

214 The shift away from managing pitch, volume and rhythm in favour of working on the textural and timbral qualities in *musique concrète* influenced the emergence of a new, avant-garde musical trend – sonorism.

215 Patkowski, *Dźwięk na taśmie magnetycznej jako element kompozycji instrumentalnej [Sound on Magnetic Tape as a Component of an Instrumental Composition]* [in:] *Horyzonty muzyki...*, issue 39, p. 3.

216 Richard S. James, *Expansion of Sound Resources in France, 1913–1940, and Its Relationship to Electronic Music* (Ann Arbor: University of Michigan, 1981), p. 79.

without the participation of musicians, and a different kind of operation of the musical spacetime.[217] The piece – a collage of 'sound photographs' – could be repeated in an identical form any number of times, without involving the performers.

In 1948, the Paris studio had microphones, several gramophones and shellac audio recorders, as well as a mixer with potentiometers, mechanical reverb and filters. In addition, working in the studio gave one access to a library of recordings of noises and sound effects used in broadcasts. Thus, the compositional techniques employed in *musique concrète* were mainly based on the experience of acousticians, radio play directors, and film editors.

Processing was limited to changing the direction and speed of tape playback (also at fixed ratios, so as to permit octave transposition), controlling and extending the dynamics, isolating a section of sound (e.g. its initial phase), trimming and looping it (e.g. by cutting a groove on a soft analogue record), overlapping tracks, and filtering frequencies. It should be emphasised that the transformation began with the very recording of sound,[218] which could exist in the work unchanged.[219]

Composers also constructed new types of tools dedicated to specialised activities (such as the *phonogène* or *morphophone*[220]). During the premiere of the monumental *Symphony for One Man Alone* in 1950, the first spatial sound control system (*pupitre de relief*), i.e. a control system for the playback volume of several differently positioned phonographs, was tested. In the *Symphony*, both musical sounds (singing, instruments) and non-musical ones (shouting, breathing, knocking at the door) are topophonically distributed in this way.

In 1951, as Schaeffer and Henry's work gained recognition in the music community, a tape recorder was purchased for the RTF studio; this proved to be a technological turning point[221]. The tape recorders

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217 Abraham Moles, *Physique et technique du bruit* (Paris: Dunod, 1952); Moles, *La Création scientifique* (Genève: Kister, 1957).

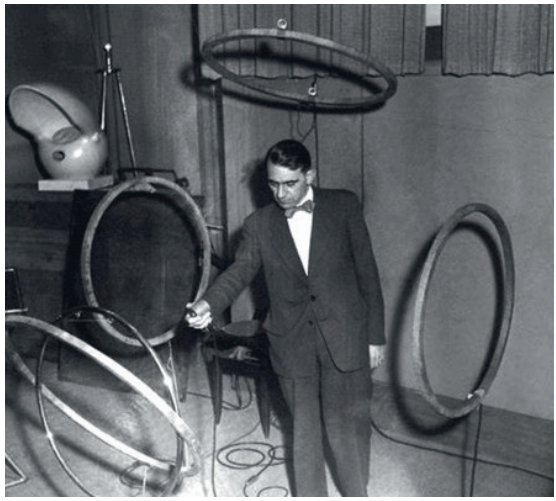
218 A great example of this effect being used in music is Alvin Lucier's *I am Sitting in a Room* (1969), which entails the repeated recording of speech sounds played back from tape.

219 In Krzysztof Penderecki's 1962 *Canon*, for example, the role of the tape was limited to recording the orchestra in concert, then playing that recording back with no modifications, only with some delay.

220 Daniel Teruggi, *Technology and musique concrète: the technical developments of the Groupe de Recherches Musicales and their implication in musical composition*, *Organised Sound*, 2007, Vol. 12, issue 3, p. 218.

221 In the 1950s, Pierre Schaeffer and Jacques Poullin built, among other things, a three-track tape recorder with ten heads that played the tape in a loop and

granted the composer broad opportunities for experimentation, good quality recordings, and precise tape processing to the hundredth of a second. In the 1960s, Robert Moog's synthesizers and François Coupigny's modular synthesizer were unveiled, although initially Pierre Schaeffer opposed the use of such equipment for composing.



Example 11. The large-coil system used by Pierre Schaeffer to control sound spatiality

In 1951, under the aegis of the Paris-based RTF, an electroacoustic studio was built, where several hundred *musique concrète* works, including dozens of compositions by Schaeffer and Henry, were created in the 1950s. The studio attracted many notable composers, such as Olivier Messiaen (there, in 1952, he realised *Timbres-durées*), Pierre Boulez (*Étude I* and *II*, 1951), Karlheinz Stockhausen (*Konkrete Etüde*, 1952). In 1954 the Paris-based studio also hosted Edgard Varèse working on the tape parts for the famous *Déserts*. In 1958, Schaeffer set up the Groupe de Recherches Musicales (GRM), staffed by new and, over time, internationally recognised figures associated with electroacoustic music, including Iannis Xenakis, Luc Ferrari, François-Bernard Mâche and Bernard Parmegiani[222].

yielded an echo effect, as well as a device capable of looping fragments of recordings at different speeds.

222 Évelyne Gayou, *The GRM: landmarks on a historic route*, *Organised Sound*, 2007, Vol. 12, issue 3, p. 203.

As the years went, more studios were established around the world, including in Tokyo (1955) and Milan (1955). By the second half of the 1960s, they already numbered several hundred. One of the first in Europe was the Experimental Studio of Polish Radio in Warsaw, launched in November 1957, on the initiative of Józef Patkowski. Composers 'experimenting'[223] there included Włodzimierz Kotoński, Andrzej Dobrowolski, Bogusław Schaeffer, and Krzysztof Penderecki. A notable trait of the Polish studio from the very beginning was the significant role of assistants and sound engineers – Krzysztof Szlifirski, Eugeniusz Rudnik and Bohdan Mazurek – who became co-creators of many important works produced in the Warsaw studio.[224]

A testament to the recording's wide-ranging processing possibilities was provided by Kotoński in his *Etude for one cymbal hit* (1959),[225] a work composed using a single sound.[226] This is also the first Polish stand-alone[227] electroacoustic composition. Importantly, the 'concrete' sound material and the techniques for its transformation did not prevent the composer from serial structuring. Another successful study is Krzysztof Penderecki's *Psalmus* (1961), based on a recording of the human voice. A quasi-serial technique was employed by Andrzej

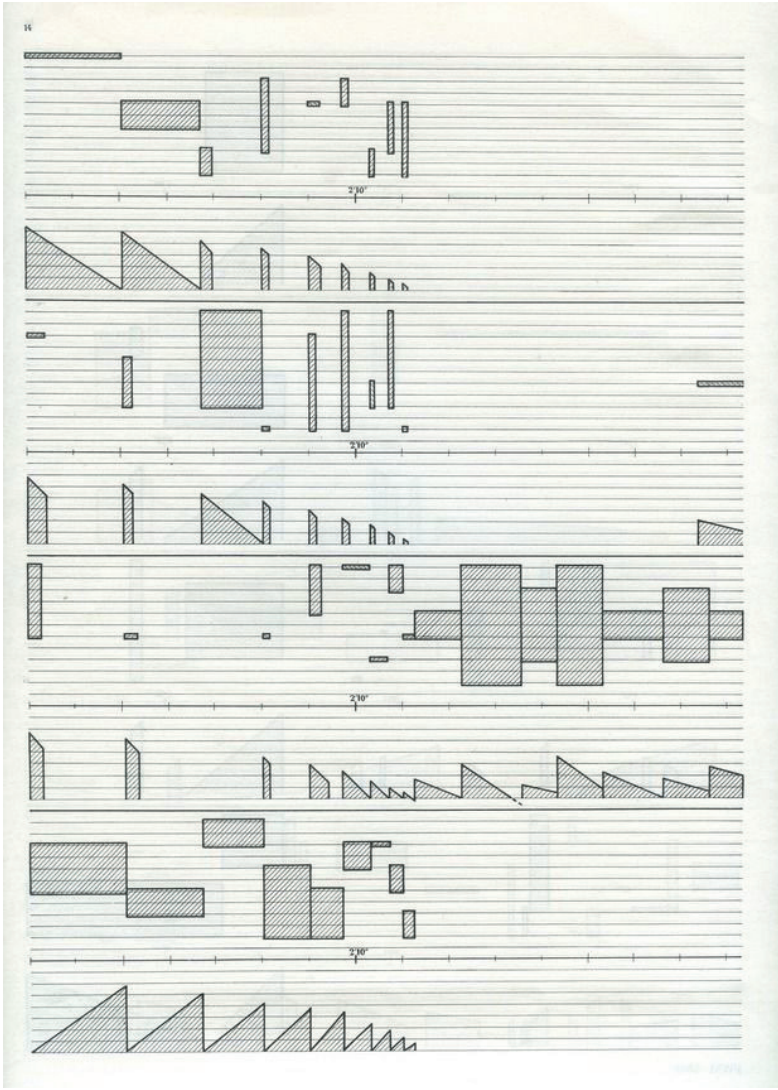
223 The studio work was done by way of numerous experiments, hence the term 'experimental music', which gained popularity in Poland. It is derived from the French terms *expèriences musicales* and *musique expérimentale*, used in 1953 by Pierre Schaeffer to describe the works of tape music, *musique concrète* and *elektronische Musik* under one term; the term remained in use until the mid-1960s.

224 They are also independent authors of their own compositions: E. Rudnik – *Lesson* (1965), *Collage* (1965), *Dixi* (1967); B. Mazurek – *Esperienza II* (1967), *Bozzetti* (1967), *Episodes* (1973), *Daisy Story* (1979) and *6 electronic preludes* (1981).

225 Earlier, in 1955, Hugh Le Caine came up with a similar idea, composing *Dripsody*, a piece based entirely on the sound of a falling drop of water.

226 The studio equipment available at the time included a pure tone generator, pulse generator, oscillograph, filters, two tape recorders, and a simple, four--input console.

227 The term 'stand-alone' is used to describe independent, non-illustrative electroacoustic music. Earlier productions of music for tape include Andrzej Markowski's music for Goldoni's play *The Servant of Two Masters* and Kotoński's music for Jerzy Pelc's 1957 film *Barwy radości i smutku [The Colours of Joy and Sadness]*. From 1957 to 1958, Markowski's musical illustrations for Tadeusz Makarczyński's film *Życie jest piękne [Life is Beautiful]* and Kotoński's film *Dom [Home]* were created. This work was realised at the Documentary Film Studios in Warsaw. Attempts with *musique concrète* were also made in the recording studio of the Warsaw State Higher School of Music, where several sound etudes were realised by acousticians Andrzej Rakowski and Janusz Piechurski. See: Kominek, *Muzyka elektroakustyczna w Polsce*…



Example 12. W. Kotoński, *Etude for one cymbal hit* (published in print in 1972)

Dobrowolski, who used electroacoustic sound material to fill the baroque form of his *Passacaglia 40 of 5* (1960). As starting material, he used recordings of five percussion sounds, which he then used to obtain a set of 40 sound objects through transformations.

These objects were included in various rhythmic and quasi-melodic arrangements (transposition was achieved by changing the speed of the tape). *Musique concrète* techniques were used on recordings of the female voice (from recitation, through singing, to various

noises), prepared piano and percussion instruments were used by Bogusław Schaeffer in *Hommage à Strzemiński* (1960). Here he made use of a *zeitregler* protosampler (among other things to downscale the voice) and spatial effects. In Schaeffer's work, a synthesis of the means developed in the area of concrete music was brought to bear by his *Concerto for Tape*.[228]

Owing to radio studios, the latter half of the 20th century saw the creation of many Polish operas straddling a territory between literary radio play, radio drama and electroacoustic composition, some composers including: Zbigniew Wiszniewski (*Neffru*, 1959), Grażyna Bacewicz (*The Adventures of King Arthur*, 1959), Tadeusz Szeligowski (*Odysseus Weeping and Abandoned*, opera-oratorio, 1962), Krzysztof Penderecki (radio play *Death Brigade*, 1963), Zbigniew Penherski (*Judgement over Samson*, 1967), Tomasz Sikorski (*The Adventures of Sindbad the Sailor*, 1972) and Andrzej Krzanowski (*Auditions*, 1973–1982).

The first compositions created in the Warsaw studio were dubbed 'experimental music', referring to the particular manner of working and obtaining sounds by way of trial and error (sometimes, it was not the composer who operated the apparatus on their own, instead merely giving directions to the producer). Bogusław Schaeffer believed that:

> Musical experimentation has always had an utopian streak in it. At times, it could be abstract. But, owing to the ability to turn the abstract into concrete, (...) every experiment made sense over time, and it is unlikely that any discoveries in music would go disregarded later.[229]

At another time, he wrote:

> Here, one does not experiment; rather, one simply creates. When one writes out a piece on paper, they do not 'hear' everything; when I work in the studio, I constantly monitor with my ears not just the result, but also the path leading to it; here, one composes and produces at the same time – something not possible in other fields of music.[230]

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228 Rather than to the form, the title refers to the virtuosity of the parts played on the individual instruments. The sound objects are fragments of recordings of a string quartet, piano, harp, flutes, clarinet, trombone, and voice. They are only processed to a modest degree. On an incidental basis, the composer enriches them with electronically generated, filtered noise.

229 Bogusław Schaeffer, *Dzieje muzyki [History of Music]* (Warszawa: WSiP, 1983), p. 490.

230 Schaeffer, *Kilka uwag na temat pracy kompozytora w studiu [A Few Remarks on the Composer's Work in the Studio]* (Warszawa: Wydawnictwa Radia i Telewizji, 1976, p. 15).

At present, the term '*musique concrète*' has lost its focus and is used primarily in a historical context. However, new terms are emerging, such as 'plunderphonics',[231] which is used to describe DJ output created using processed fragments of already-existing compositions.

1.3.2. Electroserialism – *elektronische Musik*

The rejection of the pre-compositional organisation of sound matter, experimental editing and the restriction to microphone-recorded sounds could not possibly satisfy composers associated with the Darmstadt ecosystem, at the dawn of the 1950s, which were quite steeped in post-Webern serialism. Participants in the New Music Summer Courses were introduced to the technological background of synthetic sound generation (courtesy of physicist Werner Meyer-Eppler) as early as 1950.[232] Among the students of the courses was composer and musicologist Herbert Eimert, who became head of the electronic music studio established at West German Radio (WDR) in Cologne in 1951. Since German electronic music was associated with serialism from its very beginning, the composers gathered around the newly established Cologne studio did not initially have aspirations as experimental as their Parisian peers. Eimert's aesthetical motives also initially differed significantly from those of Schaeffer,[233] whose results the German composer regarded as low-value, uncreative sound effect collages. The utterly structured electronic music was confronted with post-romantic sentimentalism, but also with post-impressionist sensibilities. Every aspect of the sound generated, and not just the result of the author's fleeting vision, was planned with precision. This becomes particularly evident when one examines the work of Karlheinz Stockhausen, who extended serial ideas to all possible musical attributes.

In the 1950s, the Cologne composers introduced the term *elektronische Musik* to refer to synthesised, electronically generated music.[234] All sounds and effects were created solely by electronic means, with zero reference to the acoustic source. This music started, as Bohdan Mazurek put it, 'an explosion of searching for new sound material'.[235]

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231 The term was used as early as 1985 by John Oswald in his text *Plunderphonics, or Audio Piracy as a Compositional Prerogative*.

232 See: W. Meyer-Eppler, *Elektrische Klangerzeugung: Elektronische Musik und synthetische Sprache*, Dümmler, Bonn 1949.

233 Pierre Schaeffer, too, was openly opposed to purely electronic music.

234 In Poland, it was initially called 'electron'.

235 Mazurek, *Materiał dźwiękowy w muzyce elektronicznej…*, p. 3.

With the arrival of synthesizers, the composition of electronic music started encompassing not just structures, but also all the sonic qualities of individual sounds. Thus, composition began concerning itself with a process that had hitherto been the responsibility of the performer. 'Not everyone has sufficiently realised,' wrote Franco Evangelisti, associated with the Cologne studio in the 1950s, 'that the traditional possibilities of sound have gradually been exhausted.'[236]

The electronic music from Cologne was initially created and recorded in a studio with several sound and noise generators, filters and electrophones, already experimented on by Eimert in the 1940s. Owing to all of these devices, it became possible to generate simple tones of any frequency and then assemble them into harmonic sounds with a regular aliquot structure or polytones not conditioned by any scales, and of any duration. At the same time, this offered the composers the potential to create sounds that were hitherto not impossible.

The most important founder of *elektronische Musik* was Karlheinz Stockhausen, head of the studio between 1963 and 1977. 'New means change the method; new methods change the experience, and new experiences change man'[237] – he said in relation to studio work. What attracted the German artist to electronic music was the precise control of all aspects of sound in a 'unified musical domain', where the shaping of many elements was possible at the same time. The full malleability of recording time, the equality of sound and noise, and the possibility of multi-layering their distribution in space became fundamental aspects of Stockhausen's electroacoustic craftsmanship. The best example of electronic serial music (along with Eimert's *Four Pieces* from 1953) was provided by the composer in *Study I* (1953) and *Study II* (1954), in which he shaped all the material on the basis of noise and generated sinusoidal waveforms. Furthermore, *Study II* was the first electronic composition to have a score, where the German composer showed a graphical representation of such sound parameters as frequency (in Hertz) and changes in dynamics over time (in decibels).

For Eimert, electroacoustics represented the idea of creating music through science coming true:

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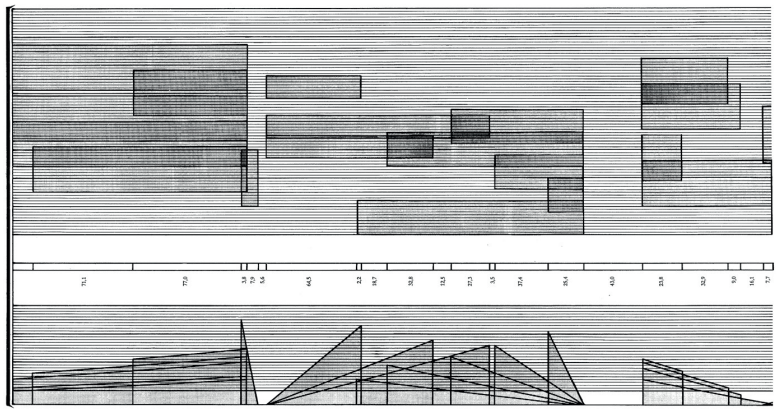
236 Franco Evangelisti, *W stronę muzyki elektronicznej [Towards Electronic Music]* [in:] *Horyzonty muzyki...*, issue 4, p. 2.

237 Karlheinz Stockhausen, *Four Criteria of Electronic Music* (audiovisual recording of 1972 lecture), https://www.youtube.com/watch?v=7xyGtI7KKIY.

> Every component, down to the smallest unit of a single note – he wrote – is subject to serial permutation. Examination of material inevitably leads one to serially ordered composition; no choice exists but the ordering of sinus-tones within a note (...) Electronic music is not 'different' music, but serial music.[238]



Example 13. K. Stockhausen, *Studie II*, p. 15

For artists using serial techniques, the precision of performance was also of pivotal importance, especially in terms of rhythm and dynamics. In the words of Kotoński:

> This kind of precision could not be ensured by live performers, whose auditory and motor habits, formed by traditional music, would bend the new, serial demands to the old musical patterns, not to mention the fact that certain rhythmic synchronisations required by the new music were virtually impossible to perform.[239]

Despite his initial distaste for the achievements of the Paris studio, as early as in *Klang im umbegrenzten Raum* (1952) or *Klangstudie* (1952), Eimert made use of compositional techniques developed in the field of concrete music. In contrast to the initially small number of synthetic sources of sound (pure tones, filtered noise), the possibilities of choice when it came to concrete objects were infinite.[240]

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238 Herbert Eimert, quoted in: Elliott Antokoletz, *Twentieth Century Music* (Wydawnictwo Pozkal: Inowrocław, 2009), p. 559.

239 Kotoński, *Muzyka elektroniczna…*, p. 26.

240 The Cologne studio also hosted the following composers: Henri Posseur, Cornelius Cardew (*Exercise 1st*, *Exercise 2nd*, 1958), Mauricio Kagel (*Transición I*, 1958–1960, *Acustica I-III*, 1968–1970), György Ligeti (*Glissandi*, 1957, *Artikulation*, 1958). The latter piece constituted an attempt to create a kind of syntactic language within the handling of synthetic sounds.

Stockhausen, who was in contact with the Paris studio as early as in his twenties, also incorporated the means of *musique concrète* in his composition *Gesang der Jünglinge*, completed in 1956. It is one of the most important electronic works that crowned the first stage of the development of studio music, and, at the same time, a fully successful synthesis of the techniques from Paris and Cologne (with Stockhausen having serialised the interval, speed, length and loudness of sound, but also its sonic qualities: complexity, saturation, depth).

The first composer to combine synthetic sounds with live performance was Bruno Maderna, associated with the studio in Milan, who composed *Musica su due dimensioni* for flute, cymbals and tape in 1952. At that time, Maderna became a collaborator of Luciano Berio, the studio manager.[241] Their work, which treats synthetic, concrete, and natural sounds on equal footing, meant that the boundaries between the terms 'concrete music' and 'electronic music' had begun to blur. Fewer and fewer pieces limited to one type of sound material were composed. At the same time, means and techniques that were less rigorous than serialism, but more expressive, were being employed.[242]

The first Polish electronic works whose entire sound material was limited to sounds obtained using generators in the Polish Radio studio were the short etudes *Db-Hz-Sek* (1962), *3 Electronic Postludes* (1962) and *Burlesque* (1963) by Zbigniew Wiszniewski. Works that were fully electronic include *Esperienza II* (1967) by Mazurek, *S for S* (1973) by Dobrowolski and *Wings* (1973) by Kotoński.

1.3.3. Sounds engraved – tape music

The term tape music (or music for tape) was coined in the USA in the 1950s to refer to works prepared in the studio and presented in concert halls as a recording played through loudspeakers. At the same time, it is the opposite of electronic and electroacoustic music played live, e.g. using electrophones. Here, the term 'tape' refers just to the medium and the type of sound source (American artists have used synthetic sounds and recordings alike from the beginning), and therefore somewhat transcends the division between concrete

241 Berio and Maderna organised the first public concerts of electronic music (*Incontri musicali*).

242 Some of the best works produced there include Berio's *Tema* (*Omaggio a Joyce*) (1958), Maderna's *Continuo* and *Omaggio a Emilio Vedova* (1960) and Luigi Nona's *La Fabbrica illuminata* for voice and tape (1964).

and electronic music. And, even though analogue magnetic tapes have long since been supplanted by digital media, the term is still used in our day.

The idea behind tape music was to exclude performance interpretation and for the creator to gain total authority over the musical material. By capturing a piece on a magnetic medium, it was to sound the same in ten years and a hundred years. As Krzysztof Szwajgier pointed out that:

> Studio music eliminates the performer consciously, aiming to fulfil one of its basic ideas: the definiteness of the compositional result. The composer (not unlike, for example, a painter), assumes full responsibility for the work, without having to fear that the performance could falsify his intentions, but also without the hope that a good musician would compensate for the shortcomings.[243]

Initially, processing techniques in tape music were limited to changing the playback speed or its direction, adding reverberation and treatments made directly on the tape (manual editing). When Otto Luening and Vladimir Ussachevsky founded the Columbia Tape Music Center at Columbia University in New York in 1951, only these kinds of possibilities were available. Ussachevsky made his first attempts at composition in 1951–1952, recording several works on tape using transformed piano recordings: *Experiment, Reverberation, Composition, Underwater Valse* and *Sonic Contours*. Luening then composed the material-homogeneous study of echo, *Low Speed* (1952), the quasi-dodecaphonic *Invention in Twelve Notes* (1952), and *Fantasy in Space* (1952), synthesising various measures. The fruit of Luening and Ussachevsky's collaboration was *A Poem in Cycles and Bells* for tape and orchestra (1954), one of the first works of electroacoustic music for an extended line-up, alongside Varèse's *Déserts*.

When it comes to tape music, a pioneering American initiative with a markedly different aesthetic was the Project of Music for Magnetic Tape initiated by John Cage in 1951. The fruit of the collaborations between the author of Imaginary Landscapes and other creators and artists (including David Tudor and Morton Feldman) was *Williams Mix*, completed in 1952. Its implementation consisted of hand-cutting and gluing brief, pre-prepared recordings according to a score of several hundred pages specifying the basic characteristics

243 Szwajgier, *Pułapka intermedialna*…, p. 36.

of sound, such as pitch, timbre and loudness. Different versions of the piece could be created based on it. In the four-minute premiere of this tape collage, as many as 600 different recordings were used.

The palette of sonic and editing possibilities increased dramatically in 1957, when the RCA Mark II tube synthesizer arrived in the studio. At that time, like other American centres,[244] the Columbia-Princeton Electronic Music Center expanded into the field of pop culture. The studios began working on music for films and commercials,[245] and for this end, Harry F. Olson constructed the Electronic Music Composing Machine, a device for generating music in a variety of styles.

The new possibilities offered by tape music inspired many composers initially associated only with traditional instrumentation, giving rise to many important musical currents. In 1961, James Tenney recorded *Analog No. 1 (Noise Study)*, a noise-based etude anticipating the noise trend. In the 1960s, through his experimentation with tape and players, Steve Reich composed works that made use of feedback (1968's *Pendulum Music* for microphones, speakers, amplifiers and performers) and the phase shift[246] (1965's *It's Gonna Rain*, 1966's *Come Out*, 1967's *Piano Phase*), which became one of the basic techniques useful in minimalist compositions.

A particular example of tape music (in this case, *musique concrète*), which was at the same time strongly conditioned by the possibilities of the sound medium, is *Jesus' Blood Never Failed Me Yet* (1971) by Gavin Bryars. The base material used in the piece is a recording of an unknown homeless man singing. The short, tonally limited stanza he performs is incorporated into a 13-bar loop. Its successive repetitions were overlaid with a harmonically rich accompaniment: first strings, then wind instruments, and guitar. As it was published on a gramophone disc, the first version of the work was 25 minutes long; the subsequent versions, owing to the greater capacity of the medium, are considerably longer: the cassette tape version lasts 60 minutes, the CD version 74.

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244 In San Francisco, New York, etc. Studios were also established at universities, where composers collaborated with engineers and programmers, e.g. at the University of Illinois at Urbana.

245 Bebe and Louis Barron used audio tape to capture the soundtrack for the film Forbidden Planet (1956), all of which is electronically synthesised music. This was the first experiment of its kind in the history of cinema.

246 It achieves this effect by playing the same material through two tape recorders. Minimal differences in the tape playback speed cause the layers to become unsynchronised. Similar techniques were employed by Terry Riley in *Music for the Gift* (1963) and *Dorian Reeds* (1965).

In the 1960s, tape music became a widely accepted and popular trend – including in Poland. In 1962, Dobrowolski's *Music for Tape No. 1* was created. The novelty of the piece lay in the use of material of various types and origins: generated polytones, piano chords, voices and sounds produced using the resonance box of the piano, into which single vowels were shouted. The original concept of composing a work without sonic concretisation, a pioneering one in electroacoustics, was created by Bogusław Schaeffer in *Symphony: Electronic Music* (1964).[247] Its graphic score includes a series of charts and diagrams with annotated directions for the performer-producer complementing the piece with sound material of own invention. 'Here, the liberation of one's own fantasy and musical imagination,'[248] wrote Bohdan Mazurek, the Symphony's first producer, 'enables more than creative performance.

Schaeffer initially opposed the surgical engineering of structures in electronic music, criticising proponents of this kind of attention to detail:

> By carefully establishing all of the musical parameters, they did not allow the piece to establish a living fabric comparable to that found in choral or orchestral music. Accuracy, while necessary (...) in architecture or vehicle engineering, is unnecessary in art, and it strips the music of life.[249]

The composer, therefore, allowed for the creation of further variants of the *Symphony* by making use of new technological possibilities – a pioneering achievement in Polish electroacoustics. He wrote:

> That is how I imagined the victory of spirit over matter, (...) a multi-version piece that never ages, a piece in which each new era can manifest its emotions, its relationship to the material, and its expression.[250]

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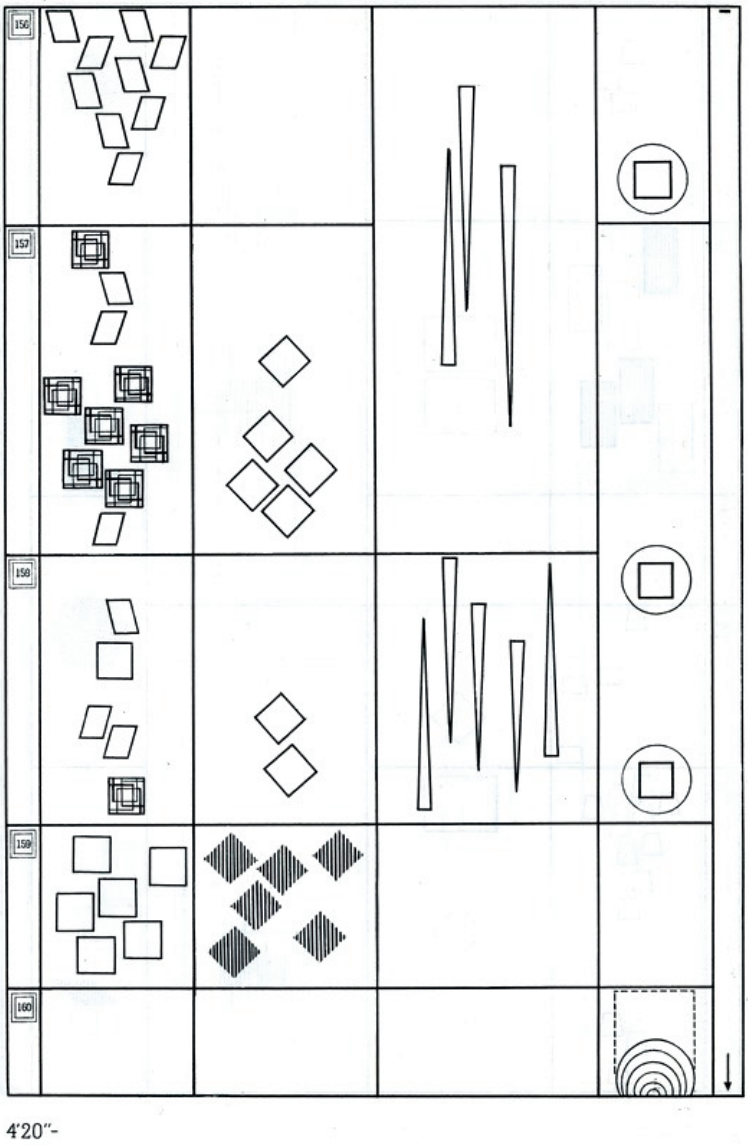
247 On the sidelines of the work on the score for *Symphony,* the piece *Music for Tape* was created, written out as a graphic ideogram. This recording was only made in 1973 in a Belgrade studio, where the composer used the Synthi 100 synthesizer, not available in Poland.

248 Mazurek, *Commentary by the producer of the score of Bogusław Schäffer's Electronic Symphony*, Polskie Wydawnictwo Muzyczne, Kraków 1968.

249 Schaeffer, quoted in: Bolesław Błaszczyk, *Bogusław Schaeffer w studio eksperymentalnym polskiego radia [Bogusław Schaeffer in the Experimental Studio of the Polish Radio],* http://warszawska-jesien.art.pl/.

250 Schaeffer, commentary on the piece *Symphony: electronic music* [in:] *Warszawska Jesień '87. 30. Międzynarodowy Festiwal Muzyki Współczesnej, 18–27 września 1987 [Warsaw Autumn '87. 30th International Festival of Contemporary Music, 18–27 September 1987]*, [programme book], pp. 119–120.



Example 14. B. Schaeffer, *Symphony: electronic music*, p. 64

In 1964, Józef Patkowski made the following diagnosis of the composers' approach to synthetic sounds and tape music:

> In the first period of electronic music's existence, there was a widespread belief that synthetic sound was intrinsically different from all others, and that it was inherently devoid of the indeterminate states that were so characteristic of instrumental sound, such as attack or decay, and that, by consequence, electronic music constituted an entirely separate sonic world. Hans Heinz Stuckenschmidt even stated that electronic music could not be combined with instrumental music – not unlike if one were to attempt to combine oil with water.[251]

It did not take long for attempts to deny similar claims to be made. Especially given that it was not easy for either composers or audiences to accept music pieced together in the studio and later played through loudspeakers, with no participation of live performers, and, therefore, with no action on stage. The objections against tape music included:

> No visual experience obtained from listening to music performed live. Furthermore, people were aware that everything that was to be presented had already been pre-decided and recorded on tape once and for all, and now, at the concert, nothing more would happen. The moment of creation, always looked forward to by concertgoers, has already taken place before, away from them, and the only thing to take place now is the reproduction. (...) Reception by radio or from a gramophone record has always been treated as a transference more so than an original performance, just as is the case with pre-recorded and reproduced instrumental music.[252]

Thus, as early as the early 1950s, mixed music, combining playback from tape with live music, began to emerge. Examples of this type of musical work include Pierre Schaeffer and Henry's *Orphée 53* (1953) for solo voices, violin, harpsichord, and tape and Bruno Maderna's *Musica su due dimensioni* (1952) for flute, percussion, and tape. When it comes to the 1950s, however, the most important work of the genre turned out to be Varèse's *Déserts* (1954). The sense of this work is based precisely on the confrontation of two seemingly-incompatible sonic worlds: the new – synthetic – and, the traditional – instrumental. As Patkowski wrote:

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251 Patkowski, *Kompozytor a technika studia muzyki eksperymentalnej*…, p. 2.

252 Kotoński, *Muzyka elektroniczna*…, p. 47.

> The case of *Déserts* arrived as quite a surprise to both ardent apologists of experimental music and its fierce opponents. The former saw an opportunity to dissociate themselves completely from the instrumental tradition, thus eschewing all of the conventions associated with the instrument and the live performer, while the latter believed that it would never be possible to combine instrumental sound with that achieved using technological means, and on this claim they diagnosed that *musique concrète* would be short-lived.[253]

Thus, starting as early as the mid-1950s, attempts were made to legitimise the equivalence of the electronic and acoustic layers, with some aiming for a synthesis, and others basing the works' dramaturgy on the stark juxtaposition of the two.

In the 1960s, the idea of merging media became widespread, and even became dominant at the dawn of the next decade. In 1962, Kenneth Gaburo composed *Antiphony III*, the first work for choir and tape. In 1963, Mario Davidovsky, exploring the possibilities of interplay and synchronicity between the live performance and the playback layer, started his *Synchronisms* cycle for instruments and tape. In contrast, Luigi Nono, in his socio-political *La fabbrica illuminata* (1964) for female voice and 4-channel tape, used sounds recorded in factories.

In Poland, among the pioneering works in this respect were Tomasz Sikorski's pieces combining live and recorded music[254] were: *Echoes II* for 2, 3 or 4 pianos, percussion and tape (1963) and *Antiphons* for soprano, piano, horn, bells, 2 gongs, 2 tam-tams and tape (1963). A similar character was also shared by compositions by Dobrowolski, *Music for tape and solo oboe* (1965), *Music for strings, two groups of wind instruments and two speakers* (1967), *Music for tape and piano* (1971), *Music for tape and double bass* (1977) and *Music for tape and bass clarinet* (1980).[255] What is important, speaking from an aesthetical point of view, is that they focus not just on the accompanying role of the tape, but on the relationship between synthetic and natural sounds.

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253 Patkowski, *Dźwięk na taśmie magnetycznej…*, p. 2.

254 Włodzimierz Kotoński calls such music electronic-instrumental or electronic--vocal music, see Kotoński, *Muzyka elektroniczna…*, p. 47

255 Andrzej Chodkowski, *Dobrowolski Andrzej* (entry) [in:] *Encyklopedia Muzyczna PWM [PWM Encyclopedia of Music],* Vol. *CD* (supplement for Vol. 2), ed. Elżbieta Dziębowska (Kraków: Polskie Wydawnictwo Muzyczne, 2001), p. 86.

1.3.4. Sonic illusions – *musique acousmatique*

For describing work that develops and extends the original idea of *musique concrète*, Pierre Schaeffer created and popularised in the community the term: *musique acousmatique*.[256] In his *Traité des objets musicaux*[257] (1966), he compared the role of the tape recorder and listening to sound without a visible source to the role of the veil used by Pythagoras during his lectures to avoid distracting listeners (the word 'acousmatic' comes from the Greek *ἄκουσμα*, meaning 'to listen'). Shortly afterwards, to summarise his 20 years of electroacoustic research, Schaeffer prepared a series of recordings, *Le solfège de l'objet sonore*, illustrating the theses contained in the treatise in practice.[258]

The idea of acousmatic music became centred around all aspects of its perception, the abstraction of sound from its source, and the possibility of simulating various acoustic phenomena. Schaeffer wanted sound to be perceived focusing not on its meaning or context, but on its abstract, sonic qualities – purely sonoristic values. It was them that were to become an area of research and development of the aesthetics of acousmatic music. This is because works of this kind are perceived by the listener without seeing the original sound source, which results in a distortion of the perceptual setting. Ewa Schreiber, on the other hand, believed that 'contrary to the utopian assumptions of the first creators of *musique concrète*, (...) the relations between the sound and its source and meaning potential are quite complex. Noises taken from nature, technology, or musical sounds, and, above all else, spoken texts, never lose their identity until the very end'.[259] Thus, in acousmatic music, one achieves either the simulation of various acoustic phenomena and situations or creates completely new virtual acoustic

256 The expression '*bruit acousmatique*' was used earlier, by Jérôme Peignot, to refer to the separation of sound from its source, which occurs in *musique concrète*, See Jérôme Peignot, *De la musique concrète à l'acousmatique*, *Esprit* (1960), issue 280, pp. 111–123, http://esprit.presse.fr/archive/review/article.php?code=16446&folder=0. The term was popularised by François Bayle, head of the IRCAM, stating that the term 'acousmatic' was better suited to music on tape than 'electroacoustic music'. David Smalley and Simon Emmerson, on the other hand, use this term to refer to music for solo tape.

257 Schaeffer, *Traité des objets musicaux* (Paris: Éditions du Seuil, 1966), p. 91.

258 Schaeffer, Guy Reibel, *Solfège de l'objet sonore* (Paris: Éditions du Seuil, 1967) (reissued 1998).

259 Ewa Schreiber, *Smaki elektroniki [Tastes of Electronics]*, *Ruch Muzyczny*, 2011, issue 13, p. 14.

spaces. High levels of simulation may lead to auditory immersion, with the listener not able to aurally distinguish between a recording being played back and an actual, live performance.

The creators of acousmatic music approached the technical problem of recording quality with particular attention. Initially, the difference between 'live' sound and that of a tape or turntable was significant. The noise, crackle and distortion of analogue media, as well as the narrowed bandwidth, made telling the difference between the sounds played back and those produced from a live instrument quite an easy task. The need for high-quality recording, processing and playback equipment meant that acousmatic music had only fully developed through digital media. As early as by the late 1970s, with a carefully prepared sound projection, the listener felt no difference between a recording and a live performance.

The primary performance medium of electroacoustic music is the loudspeaker system. Their quality has a considerable impact on the sound, thus improvements in amplification and sound reinforcement equipment were sought. Apart from this, the fact that a composer of electroacoustic music prepares and listens to his work for the first time in a studio in conditions different than those present in a concert hall was also taken into account. Due to this, matters related to room acoustics started being subjected to correction using appropriate apparatus. In the 1970s, François Bayle, head of the newly established Institut national de l'audiovisuel (at the GRM), developed an omni-directional system of dozens (in some executions, even hundreds) of loudspeakers with different characteristics, positioned at different distances from the performer and providing high-precision control of the timbre and spatial properties of the electroacoustic works being performed. The system, known as Acousmonium,[260] may assume a variety of forms and use different speaker arrangements, depending on the needs. It is even capable of replacing the traditional orchestral disposition, in which the sound spreads from different points of the stage. Such music is usually played using a computer and in rooms with precisely-shaped acoustics. An immersive acoustic environment thus organised aims to bridge the acoustic distance accompanying a traditional concert setting. With digital technology, media such as

260 It was first presented in 1974 in Paris during a performance of Bayle's *L'Expérience acoustique*. For more on the Acousmonium, see chapter 2.3.

the compact disc, omnidirectional sound systems, as well as good-quality headphones, acousmatic listening has become accessible to everyone.

1.3.5. Sound in the digital – algorithmic and computer music

Twentieth-century post-tonal sonic combinatorics (including Schönberg's dodecaphony, and Messiaen's modi and serialism) aimed at finding a new way of organising sound material. In the 1950s, these activities led to the emergence of the trend of algorithmic music, which is to say that music, in a certain sense, composed itself according to a pre-composed pattern.[261] This led to a reduction in the direct influence of the creator on shaping particular melodic, harmonic, rhythmic structures, etc. After all, this role could be taken over by a computer.

David Caplin and Dietrich Prinz began to experiment with the application of mathematical algorithms to music in the mid-1950s.[262] At the same time, Martin L. Klein and Douglas Bolitho created the Datatron software for the automatic generation of popular music. Based on a statistical analysis of the melodic and rhythmic structures of hundreds of 'pop hits' of the time, they developed a mathematical algorithm for generating melodies, aiming to appeal perfectly to the mass listener; employing this method, they generated several hundred songs. On a similar note, Lejaren Hiller and Leonard Isaacson working at the University of Illinois (Champaign-Urbana) created a pioneering computer composition known as *Illiac Suite* (1957), after the equipment used to compose it. The computer generated numerical strings, which were subsequently transcoded into a score for string quartet. The role of the creators ended in the pre-compositional phase,

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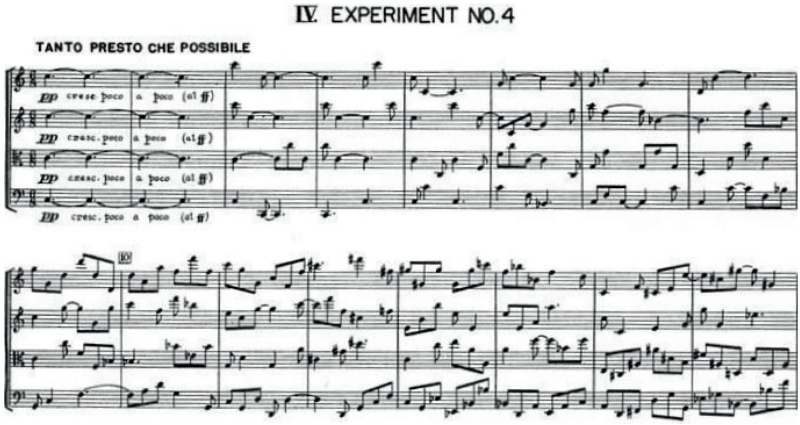
261 If the compositional process is governed by strict, structural rules, it means they may be rendered in an algorithmic form. Generative models were also created based on statistical musical analysis, identifying and codifying the structural features of works from different eras and styles. The research was particularly fruitful when it came to strongly formalised works of the medieval and Renaissance eras. Computer-assisted statistics were also used by ethnomusicologists in relation to folk music.

262 Christopher Ariza, *Two Pioneering Projects from the Early History of Computer-Aided Algorithmic Composition*, *Computer Music Journal*, 2011, Vol. 35, issue 3, p. 40, http:// muse.jhu.edu/journals/computer_music_journal/summary/v035/35.3.ariza.html.

which served to determine the overall form and principles of melo-rhythmic structuring.[263] It was therefore the first computer used for algorithmic composition.[264]



Example 15. Lejaren Hiller and Leonard Isaacson, *Illiac suite*, pt. IV

In 1956, Iannis Xenakis began working on stochastic music,[265] which was generated in a similar manner. He also made the first, not yet fully successful, attempts to combine generating equipment directly with a sound synthesizer.[266] He employed computers for carrying out probabilistic mathematical calculations used for regulating the selected parameters of sounds and preparing the scores in, among other things, *ST/10* for 10 instruments (1956–1962), *Atrées* for 11 instruments (1962), *Morsima-Amorsima* for piano, violin, cello and double bass (1962) and *ST/48* for 48 instruments (1959–1962).[267]

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263 See: Lejaren A. Hiller, Leonard M. Isaacson, *Experimental Music: Composition with an Electronic Computer*, McGraw Hill, New York 1959.

264 Ariza, *Two Pioneering Projects*…, p. 40.

265 See: Iannis Xenakis, *Formalized Music* (Paris: Richard-Masse, 1963).

266 Gareth E. Roberts, *Composing with Numbers: Iannis Xenakis and His Stochastic Music* (Worcester: College of the Holy Cross, 2012), http://mathcs.holycross.edu/~groberts/ Courses/Mont2/Handouts/Lectures/Xenakis-web.pdf.

267 Statistical mechanics in *Pithoprakta*, Gaussian normal distributions in *ST/10* and *Atrées*, Markov chains in *Analogiques*, game theory in *Duel* and *Stratégie*, group theory in *Nomos Alpha*, set theory in *Herma and Eonta*, and Brownian motions in *N'Shima*. Cf.: Marie-Hélène Serra, *Stochastic composition and stochastic timbre: Gendy3 by Iannis Xenakis*, *Perspectives of New Music* (1993), Vol. 31, issue 1, pp. 236–257, http://music.columbia.edu/cmc/ courses/g6611/spring2012/week12/gendy3.pdf.

Mention should also be made of Bogusław Schaeffer's 1955 *Study in Diagram I* for the piano, considered to be the first automatic composition of the pre-computer period.[268] Computer algorithmisation was also employed by Italian artist Pietro Grossi, starting with the mini-etude *Progretto 2–3* in 1961. The same year saw the completion of Milton Babbitt's serialised *Composition for the Synthesizer*. Another one to later deal with algorithmic music was mathematician Pierre Barbaud, author of *French Gagaku* (1969), *Machinamentum firminiense* (1971) and a theoretical work on the subject.[269]

The computer was suitable for generating sequences of random numbers, which was eagerly employed by John Cage in aleatoric music. In collaboration with Lejaren Hiller, he composed *HPSCHD* (1969), where certain musical parameters (including volume and signal filtering) were determined at random. The premiere featured 51 soundtracks played from 51 speakers, as well as 7 amplified harpsichords. Cage did the same in *Europeras I & II* from 1987. A piece of software, coded specifically for this occasion, placed singers, dancers, instrumentalists and even set pieces on the 64-section stage at random, as well as technicians with microphones for recording the non-musical sounds made by the performers and the audience. During the concert, a pre-prepared collage piece composed (also by chance, of course) of one hundred and one fragments of opera recordings was played.

Initially, the computer would only generate musical data in the form of an alphanumeric code, which then needed to be transcribed into musical notation. But as early as 1957, at the Bell Telephone Laboratories in New Jersey, Max Mathews developed and demonstrated the first digital-to-analogue converter which provided the ability to directly convert computer-generated parameters into an audio analogue signal travelling to the speakers.[270] Mathews then began work on a series of experimental pieces of software called *MUSIC-N,*[271] which were used for carrying out hybrid and digital synthesis. An example of music created this way is the *Stochastic Quartet* (1963) by James Tenney, Mathews' collaborator at Murray Hill. The use

268 Błaszczyk, *Bogusław Schaeffer w studio…*

269 Pierre Barbaud, *Initiation à la composition musicale automatique*, Dunod, Paris 1966.

270 Holmes, *Electronic and Experimental Music*…, p. 226.

271 Max V. Mathews et al., *The Technology of Computer Music* (Cambridge: The MIT Press, 1969).

of algorithmics and the Mathews system in *The Expanding Universe* (1974–1976) permitted Laurie Spiegel to build an interactive system combining a computer, keyboard, buttons, dials, and a graphics tablet.

One of the first uses of the computer by a Polish composer occurred during the creation of Kotoński's *Spring Music* for flute, oboe, violin and electroacoustic layer (1978), for which the tape part was prepared by Krzysztof Knittel at the University of Buffalo.[272] Knittel also employed the computer in his own works, including *norcet 1* and *norcet 2* from 1980. In 1985, the Warsaw studio acquired new digital equipment, including Macintosh and IBM computers and Yamaha synthesizers. This permitted a separate computer studio to be set up. The new technologies were then employed by Dobrowolski in his *Passacaglia für TX* (1988), and by Kotoński in his *Antiphonae* for tape (1989).

The work on digital sound synthesis initiated by Mathews was further developed on by John Chowning at Stanford University and Jean-Claude Risset at IRCAM in Paris,[273] bringing electroacoustics into the digital age.[274] Thanks to them, some of the most important works for the genre were created. Digital technologies enabled computers to carry out more complex and precise processing algorithms – advanced filtering, modulation, flanging and phasing, positioning in space, shaping the volume envelope, applying delay lines, looping and much more[275] – and control them in a more convenient manner.[276] Initially, their use required a great deal of time and computing power. Generating a mere few minutes of music would sometimes take entire days, therefore the role of computers was limited to their use in tape music and to aiding in the pre-compositional phase of creation. That notwithstanding, the analytical capabilities of the software gave

272 He used computer sound synthesis programmed in the MUSIC V language; see: Kominek, *Muzyka elektroakustyczna…*

273 L'Institut de recherche et coordination acoustique/musique [Research and Coordination Centre for Acoustics and Music] has been the most important centre for electroacoustic music in the world ever since its foundation by Pierre Boulez in 1977.

274 Teruggi, *Technology and musique concrète…*, p. 213.

275 A comprehensive computer analysis and resynthesis of the abstract shapes of a time-varying spectrum makes it possible, for example, to seamlessly transform one sound into another (audiomorphing). It also allows the loudness envelope of one sound to be crossed with the spectral characteristics of another. This type of action was not possible in the case of analogue media.

276 Above everything else, they allowed more convenient control of multiple tracks and channels simultaneously. As a result, with the popularisation of eight-track digital tape, eight-channel systems became popular.

composers a greater awareness of sonic aspects and even, through various experiments and research work, a better understanding of the reception of music by the listener.

The digital revolution in recording studios took around a decade, and by the 1990s the computer was already commonly used, including in home studios. It started to function as a versatile creative tool: it replaced synthesizers, samplers and hardware sequencers, permitted note editing, became a recording library, accelerated compositional processes (digital synthesis, sampling, recording, and mixing) and much more. The computer thus became a comprehensive virtual studio where the artist was able to precisely configure the environment for synthesising, processing, and recording sounds.

In the present day, all recorded music could be considered computer music, even if recorded from acoustic instruments. After all, it is recorded, processed and mixed with the use of computer software. However, with such usage, the concept loses its meaning. As Kotoński has already pointed out,

> There have been many misunderstandings regarding the term itself. People started using it to describe things that were totally different, forgetting that the computer, being a universal tool, may serve a variety of purposes, but its use does not introduce any specific features into the music produced or reproduced with its use. In other words, computer music as a genre does not exist at all. There are only different applications of computers in music.[277]

1.3.6. 'Extending' instruments – live electronics

Live electronic music, or live electronics, is, as opposed to electronic music created in the studio and recorded on tape, created in real time during a concert.[278] One harbinger of this direction were musical performances using electrophones and other sound media, practised as recently as in the inter-war period. One example of this is *Imaginary Landscape No. 1* (1939) by Cage, where the lineup, alongside a prepared piano and cymbal, included two turntables that played records containing recordings of pure tones at different frequencies at variable speeds.

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277 Kotoński, *Muzyka elektroniczna…*, p. 215.

278 In the case of music for tape and instruments, the only layer subject to live interpretation is the instrumental layer; in live electronics, both layers may be modified in real time.

In the 1960s and 1970s, the development of musical electroacoustics was invigorated owing to samplers and synthesizers, which made it possible to shape almost all of the sound parameters directly. The voltage control technology used here was also introduced in Poland starting in the 1970s.[279] This changed the way of working in the studio markedly, as previously it was based on time-consuming, manual tape editing. It became possible to create complex sound structures in much less time than before, and then – by employing synthesis – in real time. This brought electroacoustic music production closer to traditional instrumental performance.

Keyboard electrophones appeared in recording studios ever more commonly as a replacement for traditional instrumentation. Several different synthesizers were used by Terry Riley for producing the album *A Rainbow in Curved Air* (1969). The commercial use of electric instruments gained popularity with the release of an album of arrangements of Bach's works, played by Wendy Carlos using a Moog synthesizer (*Switched-On Bach*, 1968). Some important examples of synth compositions from this time are Morton Subotnick's *The Wild Bull* (1968) and *Touch* (1969), performed on a synthesizer with a sequencer and an original touchboard instead of a keyboard. The catalogue of works by Karlheinz Stockhausen and, among Polish composers, Knittel, among others, contains quite a few such works, such as, for example, *Histoire II* for clarinet, piano, synthesizer and tape (1988), *Negev I* for percussion instruments and synthesizer (1993) and a cycle of over a dozen *Sonatas da camera* for various instruments. An important piece in this category is *Concerto* for tenor saxophone (1987) by Stanisław Krupowicz.

One more interesting side of *live electronic music* is the use of a variety of media to transform the sounds of traditional instruments in real time, in the course of the performance. But, as Kotoński posited, before the advent of digital equipment, 'stage activities had to come at the price of a significant reduction in the repertoire of means available. Indeed, only part of the electroacoustic effects were attainable in a live setting.'[280] The simplest method of electroacoustic intervention is amplification, already used at the dawn of the 1970s. In Cage's *Cartridge Music* (1960), performers use contact microphones and phono adapter heads to amplify sounds that are barely audible. In

279 The first synthesizers and computers (first Moog, then Synthi AKS) appeared in the Polish Radio's Warsaw Experimental Studio in 1973.

280 Kotoński, *Muzyka elektroniczna*…, p. 50.

Child of Tree (1975) and *Branches* (1976), on the other hand, Cage connected contact microphones and high-power amplifiers to cactuses. One of the most outstanding works employing amplification is *Black Angels* for the amplified string quartet and additional instruments (1970) by George Crumb.

The simplest method for enriching an amplified signal is to add echo and reverberation. Pauline Oliveros composed a series of pieces employing these effects: *I of IV* (1966), *C(s) for Once* (1966) and *Beatiful Soop* (1967). Delay lines replacing repetition were eagerly used by American minimalists; for example, Terry Riley used tape, a delay system and couplings alongside the saxophone in his *Dorian Reeds* (1965). Other *live electronics* effects appear in Stockhausen's 'intuitive music': *Mixtur* for 5 instrumental groups, pure tone generators and circular modulators (1964) and *Mikrophonie I* for 2 performers (1964), where the only instrument is a large tam-tam, which is made to vibrate, with the sounds picked up by two microphones and then processed using filters and amplified. In Gordon Mumma's 'cybersonic'[281] projects, such as *Medium Size Mograph* for piano (1963), electronic media are used to modify articulation; in *Hornpipe* (1967), horn and valve horn sounds trigger further electronically generated tones, creating an ever-denser mass of sound.

In Poland, the earliest one to acquire an interest in live processing techniques was Kotoński, composer of *Concerto* for electronically amplified and modulated oboe and orchestra (1972), *Aeolian Harp* for soprano and 4 amplified instrumentalists (1973), and *Height of Summer* for clarinet, piano, cello and electronics (1979), where the instruments were amplified and processed live using a delay system, circular modulation and reverb. Among Polish composers, one to acquire a particular fondness for the echo effect was Hanna Kulenty, author of *Cadenza* for violin (1992), *Sinequan* for cello (1993), and *A Fifth Circle* for alto flute (1994). An outstanding example of how live electronics may be used is *Pianophonie* for piano, electronic sound processing and orchestra (1978), the last work by Kazimierz Serocki.[282] In these pieces, the sounds of the piano are captured by three microphones (one of them being a contact microphone) and

281 Holmes, *Electronic and Experimental Music*…, p. 228.

282 The piece has recently been recreated by digital means, owing to which the number of performers has been reduced.

transmitted to processing equipment, including delay lines and modulators controlled by sound directors. In addition, two tone generators are available for use by the pianist.

By the late 1970s, modifying the structure of the musical material in real time, during the performance, was becoming an ever more common practice. The aim was to alter aspects of the sound on a deeper, textural and spectral level. The advent of high-speed microprocessor computers brought about a revolution, which made it possible to integrate event and signal processing into a single sound environment, while effectively making use of real time sound synthesis. Within the framework of the performance, the computer could also be used as a conductor of sorts, controlling instruments or peripherals. Controllers (instruments) and analysers (which followed pitch, envelope, timbre) became the principal performance interfaces in live electronics music. Gestural control was discovered to have a strong performative potential. Communication between all devices usually took place via MIDI[283] and music sequencer software, whereby the music was represented digitally, as a sequence or channel of sound events with specific pitch, duration, and dynamics. This allowed the composer to create and record a file containing a path of events that were to take place during the performance, then use it to activate and control the sounds generated by the synthesizer or sampler.

Starting in the 1980s, the computer was more often included in the musical line-up, acting, for example, as a virtual 'improviser'. Many devices may be combined into interactive systems capable of tracking and 'responding' to musical events in real time. One example of pioneering use of the microprocessor computer for interactive improvisation, where the electronic system responds to different pitches played by the musicians, is *On the Other Ocean* (1977) by David Behrman. Here, computer analysis and resynthesis permitted the creation of an automatic accompaniment mechanism for soloists.[284] As early as in the 1990s, through the use of neural networks, computer systems were able to 'track' the performer and adapt to their playing.

As noted by Krzysztof Szwajgier, one of the difficulties faced by the live electronics trend is the inability to give the audience certainty that the concert is taking place entirely live ('if it is only partly so,

283 Digital technology has been employed in music for both event and signal processing (cf. Chapter 1.2).

284 See Daniel Martín, *Automatic Accompaniment for Improvised Music* [Master's thesis] (Barcelona: Universitat Pompeu Fabra, 2009), http://mtg.upf.edu/static/media/ Martin-Daniel-Master-Thesis-2009.pdf.

this unspecified partiality has a negative impact on the rest'[285]). The very use of media created to manipulate the input causes the concert setting to become ambiguous, as distinguishing between what the instrumentalist is performing and what the computer is processing is not easy.

With the popularisation of new digital media, a group of artist-programmers have been manifested, for whom it has become a natural working environment. One of the most recent techniques combining the practice of live electroacoustic music with computer composition is *live coding* – that is, 'composing' a sound-generating piece of software *ad hoc*, during a performance.[286] Among the still-modest group of Polish artists using live programming is Paweł Janicki, who creates generative and algorithmic music, as well as projects based on multidimensional fractal geometry.[287] Such activities often go beyond sonority *sensu stricto*, becoming part of multimedia art.

1.4. Multimedia shows – electroacoustic music in the art of performance

The music of recent decades, especially that associated with new media, saw the performance aspect increasingly come to the fore. This 'performative turn'[288] is part of a widespread trend in the humanities[289] and aesthetics,[290] as the culture as a whole is moving away from text to spectacle.[291] Erika Fischer-Lichte, a proponent of aesthetics

285 Szwajgier, *Pułapka intermedialna*…, p. 133.

286 Such activities are championed by the Transnational Organisation for the Pragmatics of Live Art Programming, or TOPLAP for short, founded in 2004.

287 Mirosław Filiciak, '*Muzyka i software. Zrób to sam*' [Music and Software. Do it Yourself] – *lecture and concert/performance by Pawel Janicki*, http://kultura20.blog.polityka.pl/2008/03/03/muzyka-i-software-zrob-tosam-wyklad-i-koncertperformance-pawla-janickiego.

288 Richard Taruskin, *Text and Act: Essays on Music and Performance* (New York et al.: Oxford University Press, 1995). Nicholas Cook, *Between Art and Science: Music as Performance*, *Journal of the British Academy*, 2014, issue 2, pp. 1–25; Nicholas Cook, Beyond the Score: *Music as Performance* (Oxford: Oxford University Press, 2013).

289 Ewa Domańska, '*Zwrot performatywny' we współczesnej humanistyce, ['The Performative Turn' in Contemporary Humanities]*, *Teksty Drugie*, 2007, issue 5, p. 57.

290 *Zwrot performatywny w estetyce*, ed. Lilianna Bieszczad (Kraków: Libron, 2013).

291 Artur Duda, *Performans na żywo jako medium i obiekt mediatyzacji [Live Performance as a Medium and Object of Mediatisation]* (Toruń: Wydawnictwo Naukowe Uniwersytetu Mikołaja Kopernika, 2011), p. 19.

thus oriented at aesthetics and performance studies, points out that, since the 1960s, i.e. since the beginning of the spread of new media, 'a multitude of new performance types has emerged in our culture'.[292] From today's point of view, this incredibly fertile sphere of various activities straddling the lines between theatre, music and the visual arts is proving to be one of the most important areas of creative innovation in the art of the 20th and 21st centuries. This chapter attempts to examine all of these phenomena from a musical perspective, though many of them do not fall under music by definition, even if they take sound as the basis of their creative material.

1.4.1. The happening and musical action art – the genesis and origins of the performance

In the face of artists' increasing disapproval of the visual arts as construed in the traditional sense, the 1960s brought about the seeds of many new art genres,[293] including: action painting, post-informel (post-Pollock) plastic gestures, happenings, activities by Fluxus, theatre of reality and post-dramatic theatre, and, within music, instrumental theatre. At the time, there were no sharp boundaries between these genres, and the concept of performance was not yet widespread. Performance only became an independent form of art in its own right in the early 1970s, when the term encompassed all forms of 'live art'. It ended up absorbing terms such as 'live art', 'living sculpture' or 'body art'; in Polish, it gradually supplanted the terms 'działania' and 'akcje' (actions).

Performance is, in the broadest sense, a paratheatrical art of action, where the artist takes centre stage. It is 'a succession of meaningful and symbolic actions that is a repetition of an invented or traditional pattern, typically carried out in the presence of an audience'.[294]

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292 Erika Fischer-Lichte, *Estetyka performatywności [The Transformative Power of Performance: A New Aesthetics]*, translated by Mateusz Borowski, Małgorzata Sugiera (Kraków: Księgarnia Akademicka, 2008), p. 290.

293 Performative means of artistic creation had been present in theory and practice before, but it was only starting in the 1960s that the dominance of the performative function over the referential function became clear. This stemmed from, among other things, the ever more perceptible reaction to the increasing massification and marketisation of art at the time.

294 *Performans* (entry) [in:] *Słownik terminologiczny sztuk pięknych [Terminological Dictionary of the Fine Arts]*, eds. Krystyna Kubalska-Sulkiewicz et al. (Warszawa: Wydawnictwo Naukowe PWN, 1996), p. 307.

A performance is a spectacle, and at the same time, putting something on display; it derives from body art and happenings.[295] As Władysław Kaźmierczak reminds us, performance emerged when:

> ...the radicalism of avant-garde artists had reached a grotesque climax, where there remained no more room for creativity, which had been replaced by a peculiar state of helplessness and anticipation. Performance proposed an opposite situation. It has become an unlimited freedom. It was creative, anti-market, and anti-subject. And it was striking. (...) Performance (...) undermined the very cultural foundations of art. For the first time, the artist's persona was placed before the art. It is not the rules of art or established conventions, but the human being and their sensitive mind that became important.[296]

At the end of 1959, Allan Kaprow (a student of John Cage) performed *18 Happenings in 6 Parts*, which could be seen as a kind of prototype of happening and performance. Also important to the emergence and formation of the genre were the open-ended actions by Cage and other artists associated with the Fluxus movement. Some of the clearest examples of early performance are *How to Explain Pictures to a Dead Hare?* by Joseph Beuys and *Orgien- und Mysterien Theater* (1962) by Viennese Actionist Hermann Nitsch. As far as musical performances go, Yoko Ono's *Wall Piece for Orchestra* (1962) may be considered the first one. Also pioneering for the time was Dieter Schnebel's performative and conceptual idea of 'visible music' (*sichtbare Musik*) implemented in, among other things, the 'piece' *Nostalgie* for solo conductor (1962),[297] in which the audience is expected to imagine the music purely based on the conductor's gestures (the score is only represented choreographically, during the performance). Schnebel also reached for new visual media, as in *Ki-No – Nachtmusik* for projectors and listeners (1963/1967).

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295 The sources of performative action in culture may, however, be sought much deeper: in shamanic, tribal and religious rituals. The speeches (*serate*) by the Futurists of the early 20th century and – in parallel – of the Dadaists may also be considered the prototype of contemporary performance.

296 Władysław Kaźmierczak, *Historia performance w Polsce [The History of Performance in Poland*], http://www.historia-performance.wizytowka.pl/.

297 Also in *Visible music 1* for conductor and one instrument, *réactions* for one instrument and audience, trio *Anschläge-Ausschläge*.

1.4.2. Action, body, improvisation – the key aspects of performing arts

Performance has no single binding definition, no rules and no limits, as it does not preclude any form of expression.[298] Even from the perspective of several decades, performance art eludes aesthetic evaluation and belonging to a single trend; it is a metagenre of sorts. In performance, artists not only cross boundaries between the various disciplines of art, but also seek a new, (multi)sensual contact with the audience,[299] for which they often make use of new media.

In the performing arts, the work-object is not an aim in itself. Indeed, performance was, unlike a happening, based on the identity of the work and that of the artist.[300] Moreover, the basis of performative action is the structuring of form through the artist's own bodily experience – in his 'corporeality', the artist becomes part of his work, its 'creative material'. This is why the body and the various ways in which it is used and presented – motoric (movement), semiotic ('staging the body', gestures and posture as sign), sonic (speech, singing) and energetic ('vibrancy' of the body) – have become the focus of many artists' attention.[301] In performance, the human body acts both as a medium and as a product of staging on display at the same time, a 'surface of cultural records'.[302] On its surface, signs, facial expressions, posture, clothing, appearance, and meaningful gestures work together to shift the focus from the art to the artist. The essence of performance thus

298 Jonathan Dunsby, *performance* (entry) [in:] *The New Grove Dictionary of Music and Musicians*, Vol. 19…, pp. 346–349.

299 At the same time, the audience typically does not participate as actively as would be the case during a happening. There are, of course, many exceptions: Trevor Wishart, Charlie Morrow and Pauline Oliveros organised open-air performances in which the audience created the concert performance themselves.

300 The emphasis on the sensual and the necessity of the bodily presence of the artist (who is, in a certain sense, the form of the work) brought the genre closer to body art.

301 Łukasz Guzek, *Sztuka instalacji. Zagadnienie związku przestrzeni i obecności w sztuce współczesnej [The Art of Installation. The Issue of the Relationship Between Space and Presence in Contemporary Art]* (Warszawa: Neriton, 2007), p. 329. According to Richard Schechner, on the other hand, performativity as viewed from an anthropological perspective exhibits as many as six fundamental aspects: symbolicity/semioticity, materiality/corporeality, performative 'power', processuality, reflexivity, and mediality. See: Richard Schechner, *Performatyka. Wstęp [Performance Studies: An Introduction]*, translated by Tomasz Kubikowski (Wrocław: Centre for Study of Jerzy Grotowski's Work and of Cultural and Theatrical Research, 2006).

302 Duda, *Performans na żywo…*, p. 23.

became 'the phenomenon of the human being as a whole, full of limitations, weaknesses and contradictions alike, as well as beauty, potency and sublimity'.[303] 'Performance art', adds Michał Krawczak, 'brings down the idea of a hermeneutic, essentialist personality (...). The place of the cogitoartist extrapolated to the work of art is taken by the artist as creator and material, subject and object'.[304] One vital aspect of a performative event, like a happening, is creative improvisation. It may depend on the temporary preferences of the artist, the reactions of (and, at the same time, interactions with) the audience and other, sometimes random, external factors. In this sense, each performance is unique, not unlike a jazz improvisation. The spectator, in relation to whom the performer shapes their statement, is an important element of performance structures as well.

Performance and happening, although both derived from the visual arts, share one important aspect that characterises the musical arts – temporality. Performance art does not focus on the art object or its production, but, rather, on the process happening in time and space and on the self-referentiality of this action; with performative arts, it is the process that becomes the leading factor of art.

1.4.3. Musical happening, instrumental theatre and (anti-)musical performance

Musical performance is, by its very nature, always performative. Until the mid-20th century, however, this aspect did not play a prominent role in (absolute, unstaged) music – neither for the creators nor for the audiences. This situation changed mainly owing to one of the most important and influential composers of the 20th century, John Cage. In the summer of 1952, when he was associated with the avant-garde group Black Mountain College, he took part in a staging of *Theatre Piece No. 1* (*Black Mountain Piece*). It was performed on an improvised basis, with no script or rehearsals: Jay Watts played various instruments, Cage read texts by Master Eckhart, then used a radio to make noise, and Robert Rauschenberg played old records

303 Tomasz Sikorski, *Performance – sztuka żywa [Performance – Living Art]* [in:] *Media i nowe media [Media and New Media]*, eds. Wiesław Łuczaj, Marek Świeca (Kielce: Wydawnictwo Uniwersytetu Jana Kochanowskiego, p. 28).

304 Michał Krawczak, *Przestrzenie komunikacyjne performance art [The Spaces of Communication of Performance Art]* [in:] *Komunikacja przez sztukę, komunikacja przez język [Communication Through Art, Communication Through Language]*, eds. Bartłomiej Bączkowski, Paweł Gałkowski (Poznań: Zakład Teorii i Filozofii Komunikacji Instytutu Filozofii UAM, 2008), pp. 101–110, http:// www.ztifk.amu.edu.pl/sztukako/Krawczak.pdf.

on a handheld turntable and projected his paintings and films on the walls and ceiling of the room.[305] In addition, the spontaneous reactions of the audience, the noises they made, as well as conversations and movements were incorporated into the performance.[306] The only element specified by the initiators was the timing of the respective activities, the time brackets. In a similar way, Cage performed his famous *4'33"* – a musical performance with no music. These and similar interdisciplinary initiatives influenced the further fate and development of avant-garde theatre, as well as of happening and performance art.[307] Cage was also one of the precursors of the instrumental theatre,[308] a genre popularized in the 1960s by Mauricio Kagel (*Match*, 1964; *Staatstheater*, 1967–1970; *Con Voce*, 1973; *Mare nostrum* and *Kantrimiusik*, 1975), Karlheinz Stockhausen (the quasi-happening *Originale*, 1961), and, in Poland, by Bogusław Schaeffer (*TIS MW 2*, 1963; *Quartet*, 1981, *Scenario for a Non-Existent but Possible Instrumental Actor*, 1963) and by Włodzimierz Kotoński (*Multiplay* for 6 brass instruments, 1971). The genre encompassed the most diverse forms and means, depending on the individual preferences and aesthetic views of a given artist: from the introduction of text (both phonic and semantic), movement, gesture, and acting, to the non-musical, theatrical use of instruments, to the use of electronic media.

The boundary between instrumental (musical) theatre and musical performance theatre is rather conventional, and results from the historical and environmental context. Performance, born at the intersection of different arts, is inherently intermedial in its nature and will as such never be purely musical. 'A typically-musical performance is not really possible'[309] and thus may not be distinguished

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305 Among other participants were Merce Cunningham and David Tudor.

306 Rose Lee Goldberg, *Performance Art: From Futurism to the Present* (London: Thames & Hudson, 2001), p. 126.

307 Cage's ideas were so universal that they resonated with all areas of the arts. Based on this inspiration, radical art forms, such as conceptualism and actionism, developed; Cage is also cited by pioneers of media art, such as Nam June Paik.

308 For pieces of this kind, the 'theatrical participation of the instrumentalist' is required, 'in such works, where the musical notation is enriched by remarks on theatricality, the act of recreation furthermore includes the psychological, while the musician is expected to give a performance marking individuality'; Cf. Mauricio Kagel, *Teatr instrumentalny [Instrumental Theatre]*, *Res Facta* (1969), issue 3, p. 5.

309 Rafał Mazur, *Muzyka swobodnie improwizowana – sztuka performatywna par excellence [Freely Improvised Music – Performative Art Par Excellence]* [in:] *Zwrot performatywny w estetyce…*, p. 163.

as a separate genre. On the other hand, if the concept of performance is construed in a broad sense, one may include any kind of musical performance, such as freely improvised music. Krzysztof Lipka, attempting to establish a definition for musical performance, emphasised that it consists in 'introducing into the performance of a musical piece effects that are completely excluded in the classical form of interpreting music – primarily non-tone effects'.[310] Indeed, performative means seem to revolve around the deformation and caricaturisation of the classical, traditional performance; in conceptualised, musical performance, 'sonority' is sometimes even negated.

The first performances related (sonically or conceptually) to music materialised in the activities of the Fluxus movement. In 1960, La Monte Young – a student of Cage and one of the co-founders of the movement – 'composed' a series of his best-known works: *Composition 1960.*[311] By contrast, in *The Second Dream of the High--Tension Line Stepdown Transformer* from 1962–1964 Young employed electronics.[312] Dick Higgins, a co-founder of Fluxus, initiated experimental paramusical projects as well.[313] In the mid-1960s, he was one of the first to employ a computer to randomly generate *The Book of Love & War & Death*, published in 1972. It is worth mentioning here that Higgins was the originator of the term 'intermedia', which perfectly characterises the strategy employed by artists associated with the performing arts.[314]

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310 Krzysztof Lipka, *Performans w muzyce – wybrane problemy ontologiczne [Performance in Music – Selected Ontological Issues]* [in:] *Zwrot performatywny w estetyce…*, p. 143.

311 Instead of a musical score, the creator drew up instructions for the performer, such as 'draw a straight line and follow it', 'light a fire' or 'release a butterfly inside the room'. In other, typically conceptual pieces, he demanded from the performer actions that were nigh-impossible, having him, for example, 'push the piano through the wall' or 'feed the piano with hay' in *Piano Piece for David Tudor No. 1* from 1960. See: Keith Potter, *Four Musical Minimalists: La Monte Young, Terry Riley, Steve Reich, Philip Glass* (Cambridge: Cambridge University Press, 2002), pp. 51–54.

312 The piece is part of *The Four Dreams of China* series, a light and sound installation that has not been completed.

313 Among others, *New Constellations* (1960) for any number of performers singing the sound as briefly as possible. In his *Two Contributions I* (1959–1961), an 'amusical silence' plays, as it does in *A Winter Carol* (1961), in which any number of performers are asked to go outside and listen to the falling snow. Thus, the artist, not unlike Cage in his 'apologia of silence', forces the audience to treat silence and the extra-musical as parts of the music.

314 Dick Higgins used the term to refer to the majority of activities by Fluxus; intermedia is, in his view, an area between media, but also shared by different media (cf. Chapter 2.1).

Other Fluxus members concentrated around Cage also initiated the first events and performances in the form of conceptual musical performances employing various media.[315] These actions were usually drawn up in the form of short-worded instructions, called event scores.[316] In *Wind Music No. 2* (1966) by Meiko Shiomi the performers stimulate hanging percussion instruments (gongs, cymbals, bells) using electric fans, in *Open Score* (1966) Robert Rauschenberg initiates a multimedia paratheatre in the form of a tennis match. At the same time, the anti-musical works by Fluxus aim to depreciate, liquidate, compromise or provoke musical institutions.

The popularity and richness of the unconventional means and formal concepts of the performing arts have continued to influence composition and musical performance alike. Performative elements were employed in music in an original way by Stockhausen, for whom – in contrast to the instrumental theatre of Kagel or Schaeffer – 'stage music'[317] was not so much a synthesis of music and gesture, but rather the incarnation of music into gestures encompassing the sphere of its stage presentation.[318] He combined these ideas with electronic media, e.g. in his work *Sirius* (1975–1977) for eight-channel tape and trumpet, soprano, bass clarinet and bass.

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315 The genre of 'digital conceptual music' includes the 21st-century work of Johannes Kreidler. See: Harry Lehmann, *Muzyka konceptualna i relacyjna [Conceptual and Relational Music]*, *Glissando* 2013, issue 22, http://pasiecznik.wordpress.com/2013/09/13/muzyka-konceptualna-i-relacyjna/.

316 Ken Friedman, Owen Smith, Lauren Sawchyn, *The Fluxus Performance Workbook*, Performance Reseach, 2002 (published electronically), p. 1, http://www.deluxxe.com/beat/fluxusworkbook.pdf.

317 Monika Pasiecznik believes that Stockhausen was not concerned with the conventional combination of theatre, literature and music. 'The sound, in a certain sense, "triggers" the stage behaviour, makes the stage gesture "explode", carrying a ceremoniality that is entirely altruistic and lays no claim to being theatre (...) With Stockhausen, the primary factor is always the music, and all stage action, lighting and costumes are derived from its structure.' Monika Pasiecznik, *Absolutna muzyka sceniczna [Absolute Stage Music]* [in:] *Warszawska Jesień '12. 55. Międzynarodowy Festiwal Muzyki Współczesnej, 21–29 września 2012 [Warsaw Autumn '12. 55th International Festival of Contemporary Music, 21–29 September 2012]*, [programme book], http://www.warszawska-jesien.art.pl/ wj2012/program/kompozytorzy/1744966160.

318 In many of his later works, he also detailed the choreography, the expressions of the performers, and even their costumes (e.g. in the opera cycle *Licht*). Other examples include the musical scenes *Alphabet für Liège* (1972), the radio play *Herbstmusik* (1974), the ballet *Inori* (1973-1974), the staged work *Musik im Bauch* (1975), and the choral opera *Atmen gibt das Leben* (1975–1977).

In Poland, instrumental theatre, happening and performance were practised quite often, although they functioned on the sidelines of the musical mainstream, never attaining the status of 'serious music' to begin with. From the very beginning, they were chiefly associated with the circles of visual artists and the action art,[319] including the paratheatrical activities of artists operating in Wrocław, Kazimierz Glaz and Michał Jędrzejewski: the *Sensibilist Theatre* (from 1957) and the *Catastrophic Theatre* (from 1958). In the 1960s, a continuation of the theatre and painting activities of the time were Tadeusz Kantor's happenings: *Cricotage* and *Dividing Line* (1965) and *Letter* and *Panoramic Sea Happening* (1967). Among early performance art, one may also count *Prophecy I* (1968) by actionist Jerzy Bereś and the works of one of the most important artists of the 1970s, Włodzimierz Borowski, including the series *Syncretic Shows* (1966–1971), and the anti-happening *Pubes of Taints* (1969). This artist in particular, despite being associated with the visual arts, was at the time under the influence of strong musical inspiration.[320]

One of the pioneers and most prolific representatives of live art, centered around sound and musical improvisation, is Zbigniew Warpechowski (*Poetical Quarter*, 1967).[321] The artist emphasised that it was his ambition to capture what the common denominator joining all arts, which is to say, the moment of the creative act that precedes artistic formalisation.

The heyday of the performance genres in Poland came in the 1970s and 1980s, although artists interested in such art continued to operate locally, almost in isolation. It was a time of independent experimentation – the ideas and concepts concocted in the field of visual arts did not seep into the world of music (or vice versa). Borowski recalled his experiments located on the borders of art in these words:

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319 Jan Przyłuski, *Sztuka akcji. Dziesięć zdarzeń w Polsce [The Art of Action. Ten Events in Poland]* (Słupsk: Bałtycka Galeria Sztuki Współczesnej, 2007).

320 Borowski: 'At first, I synthesised a consciousness of pure abstraction of sorts: straddling the line between music and plastic experience. I sought a form of recording visual experiences, a method of notation similar to that of musical notation, for the domain of visual arts' [in:] Józef Bury, *Kreowanie pustki – rozmowa z Włodzimierzem Borowskim [Creating Emptiness – a Conversation with Włodzimierz Borowski]*, *Opcje*, 2001, issue 5 (40), p. 45.

321 It was produced in collaboration with Tomasz Stańko in Kraków (the performer, after telling the audience that he would not be able to play the piano, began to chaotically hit its keys, while Stańko improvised on the trumpet); the second time, the author used the accompaniment of a gramophone and a piano (both in 1967).

> I wanted to compose, too. I studied Ravel, Debussy, and Chopin. I also became familiar with Stockhausen to a lesser extent. (...) I was interested in cybernetics and the origins of the computer. I have also pursued the demiurge's dreams by attempting to create form-creatures designed for living as independent beings. My creations, equipped with electro-magnetic systems, had the ability to respond to the movement of air in a spontaneous manner, by changing form and emitting light. I called them 'artons'. I followed the progress of science in these areas, but undertaking serious scientific studies seemed too difficult to me.[322]

The development of the performing arts in Poland fit in the broader artistic response to the social and political problems of the time, quite different from those present in Western Europe or the United States.[323] The actions of many artists were strongly oriented towards liberty. The current of performance has, in a way, boycotted the hitherto-existing art and its semi-commercial institutions: galleries, museums, and reviews by critics.

The first composer to contribute electronic sound media to performative means was Bogusław Schaeffer. He is the author of the first Polish musical happening, *Non-Stop* (1960), instrumental theatre in the form of a metamusical audiovisual performance for an actor, a mime, a ballerina and five musicians – *TIS MW2* (1963) and many paratheatrical works, such as the *Audiences* cycle (1964), *Quartet for Four Actor*s (1966) or *Vaniniana* for two actors, soprano, piano, cello and electronics (1978). In most of these pieces, the main component is a spoken text on musical issues – the performers act as lecturers of sorts.[324] In 1970, Schaeffer composed *Heraclitiana* for tape and any solo instrument, where he preached 'playing in the spirit of Heraclitus (...) When submitting to music on tape, the soloist should find in

322 Bury, *Kreowanie pustki…*, p. 44.

323 Some of Joseph Beuys' performances had political undertones to them already, see: Leszek Karczewski, *Performans jest polityczny. Na marginesie działań performance art Josepha Beuysa [Performance is Political. On the Sidelines of the Performance Art of Joseph Beuys]* [in:] *Formatywny Beuys [The Performative Beuys]* [exhibition catalogue] (Łódź: Atlas Sztuki, 2012), http:// www.atlassztuki.pl/pdf/beuys2.pdf.

324 Joanna Zając, *Muzyka, teatr i filozofia Bogusława Schaeffera. Trzy rozmowy [The Music, Theatre and Philosophy by Bogusław Schaeffer. Three Conversations]* (Salzburg: Collsch Edition, 1992); *Bogusław Schaeffer – kompozytor i dramatopisarz [Bogusław Schaeffer – Composer and Playwright]*, ed. Małgorzata Sugiera and Joanna Zając (Kraków: Księgarnia Akademicka, 1999).

it what CAN be done, rather than what COMES out of the music. Constantly play against the music (...)'.[325] The score for the *Heraclitiana* score features an abundance of extra-musical activities whose descriptions are not fully precise, making it possible to execute the piece as a performance for tape and painter in 1986.

Before the term performance became firmly established in the art debate, Polish artists used to call their works 'actions', 'spectacles' or 'anti-happenings'.[326] The term 'performance' was only first used in Poland in 1978 during the 'I am. International Artists' Meeting' in Warsaw. This festival, as Władysław Kaźmierczak reminds us, proved to be 'a conceptual shock for Polish artists involved in live art'.[327] Ever since, the term has become official and started to accompany many exhibitions,[328] and the issue of performativity in art received attention in theoretical reflection and discussions.[329]

1.4.4. Media performance – mediatised performance

By its very nature, a performance is a one-off event. The ephemeral nature and uniqueness of the performance setting often caused the performing arts to have a low impact, so artists began documenting them in a variety of ways. Photographs, sound recordings, accounts and descriptions became an indirect form of communication between the performer and a broader audience. However, many of the new musical-theatrical or musical-visual forms requiring audience participation – musical theatre, musical performance, conceptual music – have usually not been suitable to being broadcast on the radio or recorded on a disc. Due to this, performative music has stood in

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325 Schaeffer, quoted in: Błaszczyk, *Bogusław Schaeffer w studio eksperymentalnym…*

326 Grzegorz Dziamski, *Happening, performance* [in:] *Od awangardy do postmodernizmu [From the Avant-garde to Postmodernism]*, ed. Grzegorz Dziamski (Warszawa: Instytut Kultury, 1996), pp. 349–369.

327 Kaźmierczak, *Historia performance…*

328 Among others, *Performance and Body*, Galeria Labirynt, Lublin 1978 (curator: Andrzej Mroczek), or *Manifestations/Performance*, Galeria Sztuki Nowoczesnej Wojciecha i Krystyny Sztabów, Kraków 1981 (curator: W. Kaźmierczak).

329 See *Performance: praca zbiorowa [Performance: a collective work]*, eds. Grzegorz Dziamski, Henryk Gajewski, J. Wojciechowski (Warszawa: Młodzieżowa Agencja Wydawnicza, 1984); Dziamski, *Szkice o nowej sztuce [Sketches on New Art]* (Warszawa: Młodzieżowa Agencja Wydawnicza, 1984); Dziamski, *Awangarda po awangardzie [The Avant-garde After the Avant-garde]. Od neoawangardy do postmodernizmu [From Neo-avant-garde to Postmodernism]* (Poznań: Wydawnictwo Fundacji Humaniora, 1995).

opposition to phonography. Nonetheless, mediatisation – acoustic or audiovisual – has become a new way of recording and disseminating music.

The emergence of performance as a new art genre coincided with the years in which new audiovisual recording and communication media were becoming increasingly common. It is these two factors that allowed this field of art to spread fully. The technological solutions used within the performing arts have often revolved around aspects of fuller communication with the audience, which has been enabled by videographic documentation. Now, although the live performance could not be fully 'reproduced',[330] the performance, owing to such mediatisation, in a certain sense extended its 'lifetime' and came to exist in the artistic debate.

Following the digital revolution, art now had a better recording media and distribution channels available, and has become part of a global cyberculture. Performances may be recorded, copied, distributed and made available live via the Internet (*live-streaming*). Harry Lehmann further argues that performatively- and conceptually-tinted music has a high degree of 'virtugenicity' (*Virtugenität*[331]), that is, its spread in the virtual world is faster than in the case of instrumental music. At the same time, by incorporating the technological experience and making it an inherent part of its structure, performance fits into modern perceptual-cognitive paradigms.

In the case of performance art, two types of reception operate equally strongly: direct and borrowed media. Peggy Phelan and Robert Irwin believe that performance may only truly exist in the present; it cannot be stopped, recorded, or documented. According to them, any such form is already a mere 'representation' of a performance, existing in a completely different dimension from live art forms, even if such audiovisual recording is an intended complement to the work of art. However, there exist types of musical performance that only function in a mediatised form, such as radio plays. This particular type of theatre is an acoustically virtual performance which entails the simulation or creation of various sounds and noises.

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330 Peggy Phelan believes that the 'incidentality' and uniqueness of performance eludes faithful recording and documentation – their inclusion in the circulation of performance representation ceases to be performance *sensu stricto*, Peggy Phelan, *Unmarked: The Politics of Performance*, Routlege, London 1993, p. 146.

331 Lehmann, *Muzyka konceptualna i relacyjna*…, p. 89.

At the beginning of the 1970s, the artist duo KwieKulik – Zofia Kulik and Przemysław Kwiek – created video performances.[332] The actions they presented in 1971 consisted of the simultaneous projection of diapositives and films on several screens. The projection was interrupted several times to act with the audience in real time, which, in turn, was documented by film again. Thus, real-life relationships were deconstructed here by employing the media factor.[333]

In new media art, live performance and mediatised performance are often combined, and thus a multiplication of realities and a kind of convergence – an intermedial feedback loop – as well as a mixing of the types of interaction between broadcasters and audiences take place. These different uses and intersections of media, not merely audiovisual, would often become a field of artistic play. Some good examples of this are found the works of Grzegorz Zgraja, such as *Quartet* for two performers and video apparatus (1979), in which live action is juxtaposed with its representation having the form of an audiovisual recording. In Gary Hill's video performance, *Soundings* (1979), on the other hand, the loudspeaker, playing a pre-recorded text, became the object of various manipulations distorting the recording.

The emergence and popularisation of genres such as audiovisual performance is a consequence of the emergence of analogue and, later, digital media. Reflecting on the problem from an anthropological and historical perspective, Artur Duda notes that various archetypes of performance, such as rites and rituals, were the dominant media of many developed cultures, but their role diminished with the development of media that competed with them, such as writing and print, and, in the 20th century, electronics.

> Duda adds, however, that this does not mean that the old forms have been completely supplanted by new ones, or that live performances have been replaced by completely fresh, utterly different, mediatised performances. This was not the case at all: each new medium had to take into account the forms, conventions and viewing habits associated with existing media. (...) The result was an extremely complex – and, by virtue of that, enticing to researchers – area of mixed and hybrid forms.[334]

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332 The artists used the term *appearance*.

333 *Interview with Zofia Kulik,* interviewers: Katarzyna Rakowska, Jędrzej Słodkowski, *Gazeta Wyborcza* (*Gazeta Stołeczna* supplement), 29–30 November 2008, p. 10.

334 Duda, *Performans na żywo…*, p. 10.

1.4.5. Multimedia and interactive performance

In their quest for new means of performative expression, artists increasingly turned to electronic equipment. As early as the 1960s and 1970s, the USCO collective founded by Michael Callahan and Gerd Stern (initiator of Intermedia Systems Corporation) created multimedia art inspired by the theories of Marshall McLuhan. In their multimedia performances, the artists used strobe lights, projectors and tape recorders[335]. As one of the earliest musical performances employing electronic media – in this case, the electroencephalograph (EEG) – one may consider *Music for Solo Performer* (1964–1965) by Alvin Lucier, a piece where the musical material was obtained by amplifying and processing the performer's brain waves. These waves, amplified and then emitted by the loudspeaker, served as resonators to stimulate various percussion instruments. In the early 1970s, Pierre Henry carried out similar musical experiments, calling them *cortical art*. He used his own brainwaves and a special system by Roger Lafosse to control various synthesizer parameters during concerts.[336]

One of the first multimedia performances with electroacoustic music was Cage's *Varations V* project (1965). The activation of the sound sequences recorded on the six tapes was dependent on the dancers' movements recorded using six induction antennae (similar to those used in the theremin) placed on stage and light sensors integrated into the generators. Furthermore, contact microphones were attached to the chairs and table. An additional visual layer consisted of images prepared by Nam June Paik and an experimental film by Stan Vanderbeek. All of this was controlled and 'mixed' live by Cage, David Tudor and Robert Moog.

Pioneering works leading music towards performative multimedia include several compositions by Stockhausen (*Originale* and *Musikalisches Theater* from 1961, *Sternklang* from 1971), Maurizio Kagel (*Pandorasbox* from 1960 and *Antithèse* from 1962), Iannis Xenakis (*Polytope* from 1967)[337], Dieter Schönbach (the multimedia opera *Die Geschichte von einem Feuer* from 1968) and Bernard

335 Gerd Stern, *From Beat Scene Poet to Psychedelic Multimedia Artist in San Francisco and Beyond, 1948–1978*, http://content.cdlib.org/view?docId=kt409nb28g&&doc.view= entire_text.

336 Moreover, one such performance transcended music, when Henry performed in 1973 in Marseille for the International Congress of Encephalography, which was organised by the local Department of Neurophysiology.

337 Xenakis' first audiovisual productions were made for *Polytope* during EXPO '67 in Montreal.

Parmegiani (*L'oeil écoute* from 1970 with projected images by Walerian Borowczyk). In 1976, minimalist Philip Glass created the multimedia opera, *Einstein on the Beach*.

The performance allowed different ways of reception and involving the audience. From the very beginnings of the genre, one important skill for the performers has been the ability to intuitively cooperate with the audience and interact with them in a variety of ways. These were already possible in the happening format,[338] but, owing to electronic media, they have moved to a whole other level. Attempts to combine instrumental theatre and *live electronics* include some of the actions of the Musica Elettronica Viva ensemble created at the dawn of the 1970s, as well as the performances by Pauline Oliveiros.

Bogusław Schaeffer's 1966 *Howl*, based on Allen Ginsberg's text *Howl*, is an example of Poland's first multimedia instrumental theatre work, which, in addition to a troupe of musicians and singers, involved dancers, actors, mimes, and even live painters. Light play and film projections were also used here. At the end of the 1960s, Bohdan Mazurek, composer and sound director of the Warsaw Experimental Studio, collaborated with Roman Różycki and Wojciech Markowski in creating 'audiovisual microspectacles' and installations which were later presented at, among other places, Warsaw's Galeria Współczesna. Mazurek also co-produced Krzysztof Wodiczko's *Personal Instrument* from 1969. Jarosław Kozłowski, one of Poland's most eminent conceptual artists, has been producing works and artistic activities in the form of performances and installations since 1967, employing a variety of media: drawing, photography, light and sound. In a series of audiovisual installations from the 1980s, called *Mythologies of Art*, he tackled the issues of freedom and the social functioning of art and the artist. Among the few performative works from this time created by composers – and therefore musically oriented – one may mention *Form A*, *Form E* for wind quintet and lights (1973) by Krzysztof Knittel, as well as the paratheatrical *Whisper* for 2 sopranos, 2 mezzo-sopranos, 2 altos and a bodybuilder (1973) by Wojciech Michniewski. In 1973, these two artists, along with Elżbieta Sikora, founded the composer group KEW. The fruit of their collaboration was the first

338 In the present day, happenings are also practised outside of art, in the form of social manifestations, e.g. by environmentalists, sexual minorities, or human rights activists. The organisation of such happenings is increasingly taking place via the Internet, especially social media. One variation of the happening format is the flash mob, which is the joint performance of some action in a public space by a larger group of people who do not know one another.



Example 16. J. Cage, *Variations V*

Polish semi-improvisational multimedia project: *The Second Secret Poem* for electroacoustic apparatus and diapositives, presented at the Warsaw Autumn in 1974. From the same time come Knittel's *Points/Lines* for tape, clarinet and slides (1973) and the performance *Suita audio-kinetyczna [Audio-Kinetic Suite]* (1974) by Bogusław Schaeffer and Kazimierz Urbański.

In the 1980s, musical instrumental theatre was superseded by new, syncretic varieties of the performing arts, which, owing to the digital revolution, increasingly moved towards the use of interactive electronic media. At that time, 'Technoperformance'[339] became a multimedia form in two ways: on the one hand, it combined audio and visual means (and even those perceived by using tactile or olfactory means), and, on the other, it used digital video screens, computers, and other electronic systems. Performances of this kind may be perceived as a form of interactive communication space of sorts that preceded installations. Ever more often, performers took to using digital audiovisual media: cameras, screens, projectors, motion sensors, etc. For instance, the performances of the artist who went by the pseudonym Stelarc have focused on body art, or, rather its electronic 'extension' (e.g. *Parasite: Event for Invaded and Involuntary Body* from 1997).

Maciej Walczak, an artist with a degree in music, has been making audiovisual performances using a computer, synthesizer, and video projector since the late 1980s. The basic concept of these performances

339 Karczewski, *Performans…*

was based on showing movement through abstract images or sounds. The audiovisual results were different each time, as they were generated by a specially written piece of computer software. Thus, various interactions between the artist, the self-produced work and the audience took place. Walczak's subsequent projects increasingly employed the internet cyberspace as their medium, which enabled co-creation with other artists. In the 1980s, Józef Robakowski, Czesław Minkus, Zbigniew Karkowski, and Marek Zygmunt began their performance activities. This generation ushered into Polish performance art new qualities and, in the broadest sense, new media. Most of the creators of the first performances were genealogically linked to the visual arts community, thus musical aspects played a primary role in but a handful of them. However, in 1977, the Muzyka Centrum Artistic Association was founded, with composers such as Marek Chołoniewski – a student of Schaeffer, as well as author of 'music for reading aloud' – *ID Open Letter to Olga Szwajgier* (1977) and Krzysztof Knittel, creator of *Synesthetic Performances* (1995), pursuing vibrant creative endeavours in its environment. Composer Lidia Zielińska produced the performances *The Same* (1988), *Voices* (with Izabella Gustowska – 1992) and an untitled multimedia performance at the Ujazdowski Castle in Warsaw in 2002 during the Audio Art Festival. Jarosław Kapuściński, author of a series of intermedia performances using MIDI-controlled piano and computer-generated video-projection in real time, employs advanced technology in his works *Yours* (2000), *Catch the Tiger! 2.0* (2001), *Odense Studies* (2001), *A Point, For Example*, projection (2002), *The Point Is...* (2002), *Berceuse de la 17ieme étoile* (2003).

The strong relationship between the performing arts and new media, interactive technologies and programming became the most prominent at the end of the 20th century, when installation became a popular art genre.

1.4.6. Performativity as a new means of musical expression

For musical aesthetics, it was usually the work that came first – as a certain 'intentional object', an invariant, a creative idea – as opposed to its performative concretisation. In the evaluation of the work itself, the concert interpretation was not taken into account. Meanwhile, in music associated with new media, concretisation and interpretation must, not unlike in jazz, enter the realm of theoretical reflection, as it constitutes an artistic value equal to the intentional idea. Performance is in no small part an improvised art, where the composer is able to

liberate themselves from the need to be in complete control of sound. Similar is the case with the interpreter: a performance or installation cannot be hummed – one may only describe how it is performed or outline its possible scenarios or 'rules of the game'. A performance or a musical installation exerts its impact not through its musical content, but through a circa-musical concept.[340] As Rafał Mazur rightly points out, focusing on the sonic phenomenon in the case of improvised music does little to help, or, rather, hinders getting through to the underlying idea.[341] Its weight shifts from music to musicianship – the work itself is the creation process. According to Anna Zeidler-Janiszewska, such an extended and performative research perspective reformulates and 'enriches the image of cultural practices known to date, exposing their aspects that have been obscured by the dominance of the semiotic-hermeneutic-textual orientation'.[342]

The impact of performance on music has led artists to pay ever more attention to the non-audial aspects of performance, giving musical performance the characteristics of a spectacle or even a ritual, transcending the limits of audibility. At the same time, musical performers started moving away from the institutionalised 20th-century aesthetic. Indeed, in performance there are no boundaries indicating that some 'mistake in art' that would call its very existence into question has been made.[343] Oftentimes, this anti-aesthetical attitude even takes turns against academia. Moreover, performing arts change the relationships between the creator, the performer, and the spectator, as well as between the subject and the object. This allows the distance between artist and viewer to be reduced, and, at the same, allows one to reach the essence of the experience. Monika Pasiecznik points out, citing Harry Lehmann's theories, that composers who extend their works using extra-musical elements (paratheatrical activities, images, animations) risk being accused of desperately trying to rescue themselves from accusations of being short on purely musical ideas:

340 In the 1970s, performance became strongly associated with conceptualism. One may see this, for example, in the predilection to give works meaningful titles containing interpretative suggestion or titles that thematise such things as political, philosophical, or social content.

341 Mazur, *Muzyka swobodnie improwizowana…*, p. 163.

342 Anna Zeidler-Janiszewska, *Perspektywy performatywizmu [Perspectives on Performativism]* [in:] *Perspektywy badań nad kulturą [Perspectives on Cultural Research]*, ed. Ryszard W. Kluszczyński, Anna Zeidler-Janiszewska (Łódź: Wydawnictwo Uniwersytetu Łódzkiego, 2008), p. 87.

343 Lipka, *Performans w muzyce…*, p. 144.

> This accusation is only legitimate if one is to remain within the idealistic concept of *absolute music*, which is – as Lehmann reminds us – just as historical as any other aesthetic category (beauty, harmony, etc.), and, in the context of the reality of contemporary musical art, it is simply outdated.[344]

1.5. From video-art to soundscape – electroacoustic music in installation art

1.5.1. Images with sound – video art

Electroacoustic music may constitute a stand-alone message or accompany instrumental and vocal music, and may also form one of the layers of a multimedia work. In audiovisual art, video art and video art installations, it may constitute an equally-footed layer of the work.[345] Wolf Vostell, a German artist and co-founder of the Fluxus movement, had already been creating audiovisual objects and assemblages using monitors and television sets starting in 1958 (*Zyklus Schwarzes Zimmer* and *Transmigración 1–3* from 1958, *Wochenspiegel Beatles* from 1961, *Elektronischer dé-coll/age Happening Raum* from 1968). In 1968, along with Mauricio Kagel and other artists, he founded the group Labor e.V, which aimed to explore sound and visual art events.

Of no less importance for the beginnings of video art was the work of the Korean American artist Nam June Paik, who stated in 1957 that experimental music was the beginning of all new art.[346] His education and the beginning of his career were closely linked to the world of sound art,[347] and, in the 1960s, he created many performances and installations using musical instruments. In *Exposition of Music – Electronic Television* (1963), he combined an ox skull, 13 pianos, 13 television sets, a mannequin and several sound-emitting objects (including turntables). Later, Paik concentrated on art related to television and video, but musical elements were still present in his installations, including *Concerto for TV Cello and Videotape* (1971) and *TV Bed* (1972). The artist's works oftentimes employ cybernetics,

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344 Monika Pasiecznik, *Harry Lehmann #1*, http://pasiecznik.wordpress.com/2013/04/05/harrylehmann-1/.

345 In his first theoretical work treating video as an art medium Gene Youngblood uses the term 'expanded cinema'. See: G. Youngblood, *Expanded Cinema* (London: Studio Vista, 1970).

346 Guzek, *Sztuka instalacji…*, p. 191.

347 He studied piano, composition and music history, and was particularly interested in the avant-garde music: Schönberg, Stockhausen, later Cage (the latter's influence may be noticed, for example, in *Zen for Film*).

robotics and all sorts of electronic media, especially various types of monitors. Paik's proto-installation projects, such as the interactive, audience-involving *Participation TV*, the surreal *Global Groove* (1973) and *Guadalcanal Requiem* (1976), have inspired many other video-art artists. He used more controversial means in *Opera Sextronique*, an attempt to incorporate sex scenes into a musical performance (the premiere ended abruptly with a police raid). Paika's *Something Pacific*, exhibited in 1986, was the first interactive installation for a public space that was not a gallery. *Megatron/Matrix* (1995), on the other hand, existed as a large multimedia installation consisting of 215 monitors arranged side by side, in a single plane. The images and sounds were changed using a complex 8-channel system of CD players, computers and digital sequencers.

The beginnings of audiovisual installation art in Poland can be traced back to the 1960s, to the works of artists associated with the Foksal Gallery: Edward Krasiński and Zbigniew Gostomski.[348] In the 1970s, the development of video art was heavily influenced by the activities of the Film Form Workshop, which would 'produce' conceptual, actionist and performative projects. The *Action Workshop* produced in 1973 already bore the characteristics of a video installation, including sound actions.[349] One precursor of Polish audiovisual art and video performance was also Józef Robakowski. In the film *Rehearsal II* (1971), the author separated the visual layer (intense red) from the aural layer (traditional organ music), aiming to evoke in the viewer a sense of inconsistency in the message. In *The Dynamic Rectangle* (1971), on the other hand, electroacoustic music (composed by Eugeniusz Rudnik at the Polish Radio's Experimental Studio in Warsaw) played the role of a 'sound stimulus causing a continuous fluctuation of the colour rectangle. The scale of emotional tension was controlled by synchronicities and asynchronicities between the sound and the image'.[350] The film *Exercise* from 1973 was produced

348 The foundation for this type of art was provided by Oskar Hansen's open form theory (an example of an installation is the project prepared for the Polish Radio Experimental Studio in collaboration with Zofia Hansen in 1962).

349 Kluszczyński (ed.), *Warsztat formy filmowej 1970–1977 [Film Form Workshop 1970–1977]* (Warszawa: Centrum Sztuki Współczesnej Zamek Ujazdowski, 2000).

350 Józef Robakowski, *Akcja Warsztat [Action Workshop]* (Łódź: Muzeum Sztuki w Łodzi, 1973).

according to a graphical score of sorts. Its plot layer was reduced to letters of the alphabet appearing in a rhythmic cadence on the screen, subsequently replaced by repetitions of a single sound of a reed organ.

The same period witnessed the creation of the works of Grzegorz G. Zgraja, whose experimental films focused on the relationship between sound and image, at the same time creating 'hybrid forms breaking and blurring the genre boundaries of audiovisual arts'.[351] In his works, the artist employed musical instruments (in *Etude for Gels* from 1976) and metronomes (in *Audiovisual Experiences I* and *II* from 1977).

In the 1990s, video art also attracted the interest of composers associated with electroacoustic music, such as Jarosław Kapuściński (*Japatul* for drum, tape and video projection, 1995, *Mudry* – audiovisual composition, 1996) and Krzysztof Knittel (*Raum der Begegnung*, video installation, 1995, *Social/asocial*, 2005, *Scraps of Memory II* for 2 pianos, computer sounds and video, 2007). A full correlation of sound and image characterises the audiovisual works of young composer Łukasz Pieprzyk, such as *[Dis]integration I-III* for video and electronics (2006), or *My Passion* for choir, orchestra, electronics and video (2009).

1.5.2. Sound environments and installations

Not unlike performance art, installation art finds itself at the intersection of many different artistic genres. Its roots lie in the avant-garde art of the Futurists, Constructivists, Surrealists, Bauhaus, as well as El Lissitzky (*Proun Room* and *First Demonstration Room*, 1926), Kurt Schwitters (*Merzbau*, 1933) and Marcel Duchamp (*ready mades*, *1200 Bags of Coal* (1938), *Sixteen Miles of String*, 1942). The development of installation-type works in the 1950s was directly influenced by happenings, in the 1960s by land art, minimalism, conceptualism, assemblage, and bricolage[352] (at which time installation became imbued with countercultural tendencies and Fluxus aesthetics), and by performance in the 1970s. Installation art has its roots in visual arts, exhibition and media art, although, practically speaking, installation art may employ means appropriate to any art discipline. An installation is thus a very flexible form, in a certain sense pluralising the means of artistic expression. Installation, after all, entails combining different objects and placing them in a specific

351 See: http://artmuseum.pl/pl/filmoteka/artysci/grzegorz-g-zgraja.

352 Bricolage is the art of creating from what one has 'at hand'.

place, therefore one may understand it more as a mode of construction and representation – a compositional strategy, one might say – rather than as a distinct genre or style.

Monika Jadzińska emphasises that an installation is usually a 'large-scale artwork',[353] fitting with the changes associated with the expansion of the boundaries of artistic disciplines towards the creation of large-scale, hybrid and multimedia artefacts. *Environments* – artificially created spatial situations for passive spectators – may therefore be considered proto-installations.[354] Some pioneering musical examples are the works of filmmaker Jordan Belson and composer Henry Jacobs from the late 1950s, and, above everything the *Poème électronique* by Edgard Varèse and Le Corbusier, where light play, architecture and film projections interacted with electroacoustic music (more on this: see Chapter 2.3). Some examples of proto-installation in Polish art are *A Study of Space* (1958) by Wojciech Fangor and Stanisław Zamecznik and *The Popular Exhibition* by Tadeusz Kantor. The beginnings of installation art proper may be traced back to the activities within the area of Arte Povera in the 1970s, the works by Daniel Buren in 1970 and Michael Ascher in 1974, the neon sculptures and video installations by Bruce Nauman, and the photo-installations of Christian Boltanski. The popularity of installation art increased significantly after the 37th Venice Biennale in 1976 and 'documenta 6' in Kassel in 1977. The concept crystallised, if we may even say so, at a time when the installation of art became separated from the art of installation,[355] but also when installation art began to be associated with the use of new electronic media.[356]

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353 Monika Jadzińska, *'Duże dzieło sztuki. Sztuka Instalacji – autentyzm, zachowanie, konserwacja ['A Big Work of Art'. Installation Art – Authenticity, Preservation, Conservation]* (Kraków: Universitas, 2012), p. 100.

354 What is important in an installation is the way in which the elements are composed within space – therefore, the formal values. In environments, on the other hand, it is the mood of that space and the sensory values that count more. The environment usually creates its own space, whereas installation art interacts with the space given, in a certain sense growing into the surroundings. Important works straddling the line between conceptual art and environment art are *The Void* from 1958 by Yves Klein (exhibitions of empty space), as well as *An Apple Shrine* from 1960 and *Words* from 1962 by Allan Kaprow.

355 Initially, in the 1960s, the term 'installation' was associated with exhibitions and arranging the spatial disposition of works: Jadzińska, *'Duże dzieło sztuki'*…, p. 97.

356 For many theorists, the presence of new media is a constitutive feature of installation art; cf. J.S. Wojciechowski, *Instalacja* (entry) [in:] *Encyklopedia*

In Poland, the term 'installation' was first used in the context of the exhibition *Lochy Manhattanu, czyli sztuka innych mediów [The Dungeons of Manhattan, or Art of Other Media]* in Łódź as late as 1989.[357] The term then became catch-all term of sorts, used to describe many difficult-to-classify, interdisciplinary works of art. This is why, as late as the 1970s, the term 'installation' was used to describe many works before the meaning of the term itself had crystallised. At the same time, in the context of the broader trends in art, the 'performisation' of the installation art genre occurred. Jon McKenzie notes that 'between 1955 and 1975, a wide range of cultural practices and cultural studies attempted to make a shift from product to process, from mediated expression to direct contact, from representation to presentation, from discourse to the body, from absence to presence'.[358] It was at this time that the first installactions[359] – works straddling the line between performance and installation art – came into being (e.g. Alastair McLennan's *Hanging* from 1981, Rebecca Horn's *Einhorn* from 1972, Joseph Beuys' actions or Wojciech Bruszewski's series *A Little Music* from 1982). Performance and installation art 'happen in time', but differently than is the case in, for instance, theatre, as they have no need for dramaturgy – owing to this, they can be 'read' non-linearly, not unlike a painting or sculpture. In a visually-oriented installation, the time factor is relegated into the background, contrary to a sound installation, which is a spatio-temporal art.

1.5.3. The basic features of installation art

The possibility of applying new technological solutions to art – such as digital computer systems or graphic and tactile interfaces – inspired artists of all kinds, especially in the 1990s, when multimedia interactive installations became the dominant trend. In this form, they have a number of traits characteristic of works related to new media:

— multimediality, multi-sensoricity and immersivity;
— spatiality, contextuality and conceptuality;
— hypertextuality, intertextuality and interactivity.

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powszechna PWN [PWN Universal Encyclopedia], Vol. 3 (Warszawa: Wydawnictwo Naukowe PWN, 1996), p. 6.

357 Guzek, *Sztuka instalacji…*, p. 8.

358 Jon McKenzie, *Performuj albo… Od dyscypliny do performansu [Perform or Else: From Discipline to Performance]*, translated by Tomasz Kubikowski (Kraków: Universitas, 2011), p. 48.

359 Kluszczyński, *Sztuka interaktywna…*, p. 217.

All of these features must be discussed in more detail.[360]

Installation art, not unlike performance, is a metagate of sorts that may combine means and elements of all art disciplines. Although it has its roots in the visual arts, it is a multimedia form of art in nature; it usually carries an audiovisual message, extended by a tactile dimension (that is, the possibility to touch the components of the work), and less often by an effect on the other senses: smell, taste, temperature sensation, prioperception (sense of balance), etc. Installation art is, therefore, associated with a new way of perceiving the work. The aim here is to create a total experience, involving all the senses and the whole body and leading to a loss of orientation, or perceptual immersion. Łukasz Guzek believes that the most important aspect of the genre is the relationship between space and presence, or 'presence composed into space',[361] as the creator of a given installation takes into account all the physical (acoustic) and visual aspects of the site of its exhibition. The work attains meaning in the context of its time and location, whose space becomes a kind of frame. Then, the content of the installation is also able to take the form of documentation or reconstruction, where objects only become carriers of meanings and ideas in relation to the installed space. Employing the features of the exhibition site and sensual elements forming a certain kind of unity with material elements[362] makes the installation contextual art in its entirety. Building spatial structures on the basis of electronic media, their juxtaposition, and their interaction in (or with) space provide a view of the elements involved, which define themselves by creating a background for one another.[363]

Guzek believes that 'the features of installation art were so different that they could not be integrated into the modernist thinking territory'.[364] Installation art is, therefore, a typically postmodern form, characterised by realism, pragmatism and literalism. In addition, it may also be a work in progress, without a fixed final result, but with a defined field of activity for those interacting with it. Over the production and end result of art, artists prioritise experience and communication with the audience. At the same time, the conceptualism

360 See also: Chapter 2.1.

361 Guzek, *Sztuka instalacji…*, p. 6.

362 Jadzińska, *'Duże dzieło sztuki'…*, p. 95.

363 Wojciechowski, *Instalacja*…, p. 63.

364 Guzek, *Sztuka instalacji…*, p. 81.

of the work allows one to avoid having to evaluate the execution of the artwork in favour of the artistic idea itself – a creative idea for which the matter of the work becomes merely a pretence.

Oftentimes, one may identify several levels and layers of information in an installation. There is no one continuous narrative, but a simultaneity of events 'navigated' by the interactor. This makes installation art similar to virtual hypertext – a manner of organising data in the form of independent lexia, connected via hyperlinks. It is a structure in which information is expressed in the form of a collection (a stack) of many independent texts, over which a network of various links is superimposed, and which offers some kinds of 'devices' for information retrieval. Hypertext is, not unlike installation, characterised by non-linearity, non-structurality, and crossover relationships between levels and elements. This, in turn, means that there is no predefined reading order, and the direction of the text is decided by the user. Hypertext reads like an encyclopaedia rather than a novel. One may browse it from anywhere, then move to the next section via links or search.

Combining (not always artistic) objects and media by employing new technologies and while using the given space premeditates the presence of a spectator or interactor in the space. They are forced into a direct confrontation with the work, which may in turn 'express' itself fully owing to this confrontation. A hypertext installation generally presupposes the active – though to varying degrees of awareness – participation of the viewer. By 'activating' the work, they may take on the role of a performer – 'navigation' subsequently becomes an element of artistic play and takes on the characteristics of a performance of sorts. Installation art is, therefore, interactive art *par excellence*. After all, not only an artefact, but also its actualisation, may be considered a work of art, created – within the framework of established rules – by the viewer himself. This involves admitting the factor of chance, and the creator is not able to fully predict what the interactor will do, even if several different scenarios for the actions of the latter are planned.[365] Other aspects manifest in the more specialised genres of installation

365 Wolfgang Welsch calls this phenomenon contingency – the 'emancipation of the adventitious'. Welsch shows it through the example of John Cage, one of installation art's antecedents. See: Welsch, *Stając się sobą [Becoming Oneself]* [in:] *Problemy ponowoczesnej pluralizacji kultury. Wokół koncepcji Wolfganga Welscha [The Issues of Post-Modern Pluralisation of Culture. Around the Concepts of Wolfgang Welsch]*, part 1, ed. Anna Zeidler-Janiszewska (Poznań: Wydawnictwo Fundacji Humaniora, 1998).

art, including network projects (net art, GPS-art), telematic projects (if remote interaction is involved), extending and modifying the body (cyborgisation), and simulation and virtual projects (virtual reality). In the context of the work's subject matter, of particular importance will be genres related to electroacoustics, namely installations and sound sculptures.

1.5.4. Installing sound – sound installations

Electronic media enable one to construct complex temporal and spatial relationships. A sound installation is therefore able to integrate the most diverse, sometimes non-artistic, objects that produce sound in any way. By having a sound layer, it becomes more than a mere arrangement in space – it becomes a spatio-temporal form.[366] This makes use of interactive technologies, computer systems, sensors, moving mechanical structures, graphical, tactile interfaces, and much more.

The first interactive audiovisual project was created by Robert Rauschenberg and Billy Klüver. Their *Soundings* in 1967 was an environment that reacted with different levels of light intensity to the noise level inside the room. In Ted Victoria's *Solar Audio Window Transmission* (1970), on the other hand, solar panels would trigger a series of radios whose loudspeakers were placed right next to the window pane, so that the listener was only able to hear the sound by bringing their ear close to it.[367]

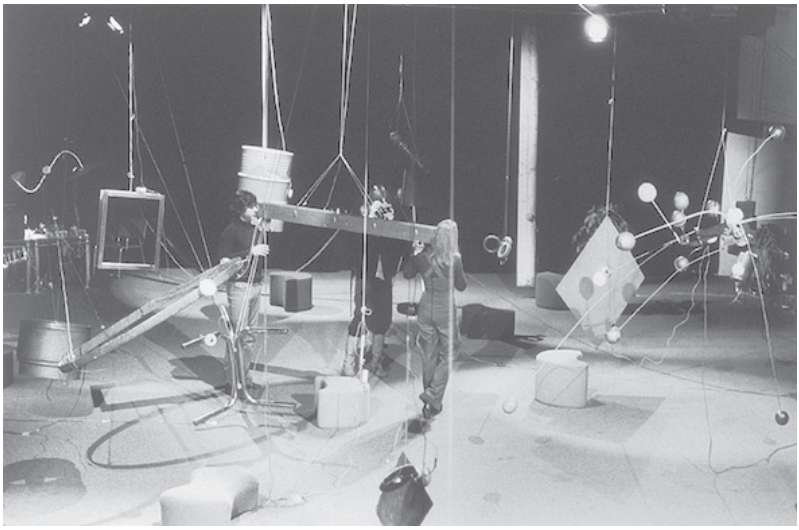
A pioneer of video art and installation art in Poland was Wojciech Bruszewski, a member of the Film Form Workshop. In the late 1970s and early 1980s, this artist produced several works focused on sound, adopting a different strategy in each. In the installation *TV-Hen* (1979), he attached to a TV screen a sensor reacting to changes in light emission and triggering a sound generator that imitated clucking. In *Stermusik* (1979), a sound camera reacted to the turning of the pages of the 'Stern' magazine located in its field of vision. In the radio installation *The Infinite Talk* (1988), Bruszewski synthesised two

366 *Instalacje muzyczne [Musical Installations]* [in:] *Sztuka młodych 1975–1980 [The Art of the Youth, 1975–1980]*, ed. Maryla Sitkowska (Warszawa: Młodzieżowa Agencja Wydawnicza, 1987).

367 Edward A. Shanken, *Gemini Rising, Moon in Apollo: Attitudes on the Relationship Between Art and Technology in the US, 1966–1971*, http://www.artexetra.com/Gemini.pdf.

voices holding a dialogue. The material for their virtual conversation consisted of excerpts from philosophical treatises, selected at random by the computer system.

One of the first sound installations to employ electronic media was *Rainforest IV* (1973) by composer and performer, David Tudor. This large-scale installation was made up of, among other things, various instruments and objects, acted as an interactive sound environment intended to be experienced spatially – audiovisually, from a distance – and physically, with the other senses. The main idea of this project was to 'filter' the sounds emitted by the loudspeakers through physical objects made of different materials that, by way of attenuating or resonating with the acoustic signal, modified its sound. Thus came into being a 'sound sculpture' of sorts, producing microsounds recorded by contact microphones placed on the surface of the objects and then amplified and played back from loudspeakers.



Example 17. D. Tudor, *Rainforest IV* (1973)

In 1968, Krystyn Zieliński and Andrzej Łobodziński created one of the first Polish sound installations at Galeria Foksal, setting up a system of loudspeakers in an empty gallery to emit various, usually abstract kinds of sounds. In the same year, composer Zygmunt Krauze (in collaboration with architect Teresa Kelm and sculptor Henryk Morel) presented *Spatial-Musical Composition No. 1*, a labyrinth with a sound system playing from six pre-prepared tapes. It was a fully multimedia work, as it engages not only the senses of distance,

but touch as well. In *Automatophone* (1974), Krauze used 15 playing mechanisms and 15 amplified plucked instruments, in *Fête galante et pastorale* (1974 – 1st version; 1984 – 2nd version) he employed 6 groups of instruments and 13 tapes spread over the 26 chambers of Eggenberg Castle in Graz, and in *Aria* (2007) he deployed 21 sources of sound in the exhibition hall, with a total of 63 loudspeakers. One characteristic trait of the composer's works is his approach to musical time. He usually prepares the sound layer of his projects in such a way that one may pause listening to it at any time, without losing the overall sense of the music. This original form – heralding, in a certain sense, the soundscape and ambient currents – created new possibilities for reception. 'This is the kind of music that awaits the listener'[368] – writes Krauze.

Another creator of several sound installations is a Polish artist working in the United States – Mirosław Rogala, author of, among others, *Pulso-Funktory* (1977), where he employs light-sensitive flooring, and *Electronic Garden/NatuRealization* (1996). Video projection, alongside the amplification of instruments and tapes, was employed by Jarosław Kapuściński in the works *Glass of Water* (1993), *Koan* (2003) and *Enso* (2005).[369] Increasingly inclined to use the installation art form are also composers who are primarily concerned with instrumental works; suffice it to mention the children's installation *Museum of Sound* (1988) and *Motetus Universalis* (1997) by Lidia Zielińska and the audiovisual installation in the form of a sound collection, *IMAGE/ILLUSION* (1999), by Rafał Augustyn.

1.5.5. Multimedia hybrids – soundsculpture and site-specific art

A sound sculpture is, simply put, a sound-producing object, or, speaking more broadly, a three-dimensional spatial form generating sound by means of an internal mechanism or external factors.[370] It is a certain kind of extension of installation forms with its roots in intermedia art, with the source of sound and the mechanisms producing it usually being the internal structure of the sculpture. This feature distinguishes it from installation art, whose spatial arrangement 'goes outside' somewhat.

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368 Zygmunt Krauze, *Muzyka przestrzenna [Spatial Music]*, http://www.zygmuntkrauze.com/pl/muzyka/przestrzenna.html.

369 See: http://jaroslawkapuscinski.com/writing.html.

370 Hugh Davies, *soundsculpture* (entry) [in:] *The New Grove Dictionary of Music and Musicians*, Vol. 23, p. 785.

As early as the 19th century, inventor Charles Wheatstone constructed complex mechanical sculptures (e.g. *Acoucryptophone* from 1821 or *Diaphonicon* from 1827[371]). In the first half of the 20th century, instrument-sculptures were built by Harry Partch, in the 1950s by the brothers François and Bernard Baschet (*Structures sonores* and *Waterphone*).[372] In his *Broadcast* from 1956, Rauschenberg, who was among the first to initiate experiments that involved combining art and modern technology, attached three working radios to a canvas painting. He continued this idea in several subsequent works, extending it to include the possibility of viewer intervention – in the 1965 sculpture-installation *Oracle*, the viewer was able to adjust the radios. Harry Bertoia's sculptures from the early 1960s often relied on a distinctive design of the plinth, which supported thin vertical bars that could be set in motion, causing them to collide with one another. This creator released a series of albums sharing the title *Sonambients*, featuring this type of concert-performance using his own instruments.

Of no small influence on the installations and sound sculptures was kinetic art.[373] One pioneer of this movement was one of the most important post-war French avant-gardists, Jean Tinguely (1925–1991), creator of mobile sculpture-machines and sound installations, known as *meta-mechanics*. It was he who, in 1982, in collaboration with Niki de Saint Phalle, created the famous *Stravinsky Fountain* at the Pompidou Centre in Paris.

As early as the 1960s, many composers and performers used ready-made sculpture-instruments for their concerts and performances; for instance, John Cage made use of Alexander Calder's works on several occasions, Herbert Deutsch employed Jason Seley's welded metal sculptures in his in *Contours and Improvisations* (1963), and Leo Nilson used Olle Adrin's designs in *Skulpturmusik* (1966). Increasingly, these events were accompanied by new – analogue and later digital – sound media. In *Structures métalliques* (1961), Pierre Mercure used tape recordings in addition to Armand Vaillancourt's sculptures, and Frans de Boer Lichtveld constructed Artaudofoon, a sculpture based

371 Ben Byrne, *Murmur* (Sydney: University of Technology, 2012), p. 60, https://opus.lib.uts.edu.au/bitstream/10453/21836/2/02Whole.pdf.

372 François Baschet, *Les sculptures sonores: the Sound Sculptures of Bernard and François Baschet* (Chelmsford: Soundworld Publishers, 1999).

373 John Grayson, *New Materials and Methods for the Musical Instrument Designer, the Audio-Kinetic Sculptor, Musician and Composer*, Leonardo, 1970, Vol. 3, No. 3, pp. 295–304.

on amplified percussion instruments operated by three performers for the theatrical music to Peter Schat's First Essay on Electrocution (1966).[374]

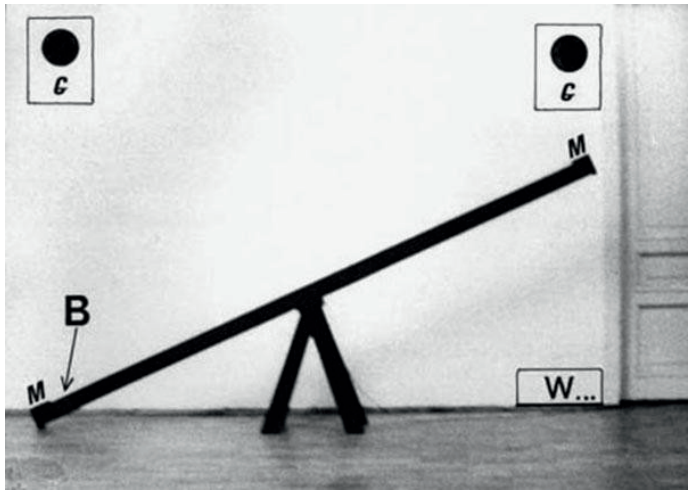
The novelty sound effects of the sound sculptures were sometimes recorded by the artists on tape. In 1963, Toshi Ichiyanagi recorded the processed sounds produced by sculptures by Jean Tinguely and the Baschet brothers. While working on her album *Fly* (1971), Yoko Ono used Joe Jones' automatic instruments in which small electric motors moved rubber parts, and these, in turn, gently struck the diaphragm or the strings, creating a quiet and pulsating rhythm. In the 1970s and 1980s, Joe Jones himself constructed many similar sculptures, including *Chitarra* (1973), *Sound Sculpture* (1974), *Music Box* (1974), *Violin #1* (1974), *Musik Kit Xylophon* (1975) and *Street Piece for a Clochard* (1987).[375] Performances using these sculptures were sometimes recorded and later published as albums (e.g. *Xylophone* from 1976, *Joe Jones in Performance* from 1977[376]). In Poland, Józef Robakowski had already been making interactive objects and mental objects since 1969 (*Spatial Self-Portrait*, 1969; *Chair*, 1970; *Rolls*, 1970) and musical objects (*Balance Beam – Interactive Object*, 1972).

The sources of sound changes were various electromagnetic mechanisms and transducers (Panayiotis 'Takis' Vassilakis, *Sound of the Void* from 1963, among others), pneumatic and electromechanical mechanisms (David Jacobs), as well as solar panels (Alvin Lucier, Liz Phillips), wind turbines (Peter Appleton, James Seawright), or radio-electric receivers (Paul de Marinis, Juan Downey). One of the first to use loudspeakers, although still controlled electrically, was *Dick Raaijmakers his in Three Ideofonen* (1967–1971). In 1969, Mauricio Kagel constructed the *Rahmenharfe*, an instrument built using six-metre-long strings whose vibrations were subjected to amplification, in a manner similar to those in an electric guitar. Even more radical was Alvin Lucier's *Music on a Long Thin Wire* (1977), an almost 30-metre-long monochord excited by means of an electronic oscillator. Large mechanical sculpture-instruments were created by the duo Peter Bosch and Simone Simons, including the

374 Artists such as Alvin Lucier, Michael Brewster, or Christina Kubisch used multi-track tape recordings (usually in the form of loops) and later digital radios and turntables in their sculptures. See: Hugh Davis, *Sound sculpture* (entry) [in:] *The New Grove Dictionary of Music and Musicians*, Vol. 23..., p. 786.

375 See: http://www.artnet.com/artists/joe-jones/past-auction-results.

376 http://www.ubu.com/sound/jones.html.



Example 18. J. Robakowski, *Balance Beam – Interactive Object*, BWA Room, Zakopane 1972 (M – microphones, B – moving ball, G – loudspeakers, W – amplifier)

noise-producing machine called *Krachtgever* (1994–1998), built of dozens of spring-connected wooden boxes whose vibrations were controlled by a computer.

The creator of the first interactive sculptures in which sound played a prominent role was drummer Max Neuhaus. For this end, he used sequencers and music players controlled using a system sensitive to various changes in the environment (*Water Whistle* from 1971). On a broader scale, similar automechanical solutions were employed by a musician-engineer nicknamed Trimpin, an expert on combining computer interfaces with acoustic instruments who would oftentimes collaborate with a composer, Conlon Nancarrow. One of his largest projects, *Roots and Branches*, is a multi-instrument structure shaped like a huge, conical tree, whose 'branches' are a spatial arrangement of several hundred guitars.[377] Some of the instruments used are controlled (even tuned) using MIDI, so that they 'play' excerpts from well-known American pieces.

From 1980 onwards, sculptures containing electronic circuits, oscillators and sound transducers enjoyed increasing popularity among artists. Electromechanically and computer-controlled sound sculptures were created by people like Jacques Rémus, Peter Sinclair, Pierre Bastien, Kent Tankred, Peter Vogel, Ken Butler, Matt Heckert,

377 The sculpture was installed at the Museum of Pop Culture in Seattle.

and Erwin Stache. The popularisation of tactile and non-tactile interfaces caused an increase in the number of electronic and electroacoustic interactive sculptures, where the actions of the audience – the interactors – played a key role, directly influencing how the sound layer was generated and modified in real time. Michel Waisvisz created many such sculptures – virtual electronic instruments – based on things like his Kraakdoos synthesizer and touch panels. In 1968, composer, performer, and instrument builder, Godfried-Willem Raes,[378] founded the Man and Machine ensemble building musical robots. In 1986, on his initiative, the *Concerto for Pneumaphones*, or for wind instrument sculptures, was performed and recorded. Similar sound robots were created by Chico MacMurtrie, co-founder of Amorphic Robot Works – an engineering and composition group producing performances and installations based on the idea of the relationality between sound and movement since 1992.[379]



Example 19. Trimpin, *Roots and Branches*, The Museum of Pop Culture, Seattle

378 In the 1990s, he became a specialist in the fields of technology and electronic art, including virtual instruments. Raes is the father of a programming language called GMT, used for real-time algorithmic composition.

379 Among his most important works one may find *Urge to Stand*, an interactive sculpture installed in the Yerba Buena gardens in San Francisco, *Fetus to Man*, a sculpture-clock in Lille, France, and *Growing Raining Tree* at the Contemporary Arts Center in Cincinnati.

In a sound installation, objects are organised not only internally, but externally as well. When they make use of the acoustic peculiarities of the site and the exhibition space becomes an integral part of the installation, or when the relationship between the space and the structure of the work becomes relevant for the installation,[380] one may speak of a particular variety of installation art: *site–specific*. Such sculptures may become part of the natural landscape and take on a monumental size[381] or assume the form of smaller 'sound gadgets' encouraging interaction.

The influence of the environment and the audience in shaping the musical material was used by Arne Nordheim and Arnold Havteland in an outdoor sculpture they set up at the Cultural Centre for the Blind in Skjeberg. Light photocells hidden around the sculpture controlled voltage-controlled devices playing electronic music. The emission of sounds in a loop (4 separate tracks) depended on the time of day, the amount of cloud cover and the shadows that the visitors cast on the photocells. Another open-air piece using sound reinforcement, radio telephony, light effects and ambient sounds is Stockhausen's *Sternklang – Park Music for 5 Groups* (1971).

Sometimes, an artist creates a whole set of sculptures for a specific place, consciously exploiting its peculiarities. Thus, an environmental sound installation is created. Such spatial arrangements of different sound sources were already being created in the 1960s, e.g. *Soundings* from 1968 by Rauschenberg. The viewer may touch elements of the sound environment, sometimes even modifying the structure of the sculptures themselves. Another example of such work was *Making the Walls Quake as if They Were Dilating with the Secret Knowledge of Great Powers*[382] by Katarzyna Krakowiak – a design for the Polish pavilion, presented at the 13th International Architecture Exhibition

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380 Kluszczyński, *Sztuka instalacji w świecie (multi)mediów. Zarys problematyki [Installation Art in a (Multi)media World. An Outline of the Subject]*, *Rocznik Rzeźba Polska* (1998), Vol. 7, p. 65.

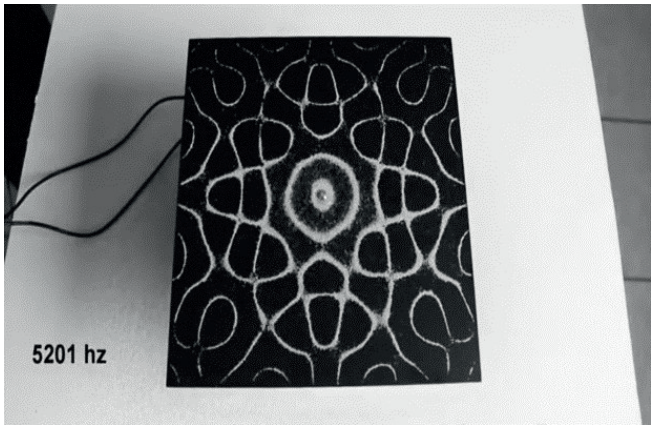
381 Such ideas were already being executed by Renaissance artists, who would build, for instance, all kinds of water organs, aeolian harps, or musical fountains, such as the singing fountain from 1564 at Prague's Hradčany Castle. Present day: The *Singing Ringing Tree* grown in the hilly, rugged landscape of Burnley in north-west England, or the *Sea Organ* installed in the Croatian coastal city of Zadar.

382 The title is a quote from the novel *Dombey and Son* by Charles Dickens. Its author describes the noises and vibrations felt by residents of buildings near the London railway line.

in Venice (2012). In this case, the sound layer consisted of noises heard in the building, including from conversations, amplified trembling of the walls, and ventilation systems.

A special case when it comes to the soundsculpture genre is the visualisation of sound waves – the actual acoustic space of sound and its vibrations. These peculiar, moving reliefs may be obtained by directing the amplified sound waves onto a mirror of water or other liquid substances, or by spilling some light, loose material onto the resonating plate. The different frequencies of the plate's vibrations – corresponding to different pitches – resonate and arrange the powder into various symmetrical figures (similar to experiments with magnetic fields and steel filings). This effect is difficult to achieve without the use of an amplification system, as a high volume of sound is needed.

The field dealing with the experimental study of this phenomenon and the real effects of sound vibrations on matter – including the human body – is known as cymatics.[383] It is worth noting that the results of these experiments became a valuable inspiration for sound visualisation artists; they showed how to transform music into shapes and images in a natural way. Cymatics was employed by Alvin Lucier in *Queen of the South* from 1972 and visual artist Ron Rocco in his 1986 installation *In Light of Sound* for synthesizer, mirrors and laser, one part of the *Andro-media* series.



Example 20. Cymatic visualisation of a sine wave

383 See: http://imaginarium.org.pl/index.php?option=com_content&view=article&id=401:cymatyka&catid.

1.5.6. Sonic sceneries – acoustic ecology and soundscape

A genre close to the acoustic environment type is the *soundscape*. The concept first emerged in the domain of sound ecology, a field initiated by Canadian composer, Raymond Murray Schafer. In the late 1960s, the World Soundscape Project research project was developed at his initiative, aiming to draw attention to environmental sounds, deepening acoustic awareness, and awakening the need to 'listen more deeply'.[384] He proposed, among other things, exercises in the form of a sound walk,[385] which could be accompanied by field recording practice; he also suggested building special parks and gardens containing instruments and sound sculptures. Such places have been created since the early 1970s (including John Grayson's children's park in Vancouver). Works of this type were also installed in public spaces, airports, train stations, and busy streets. Some examples of those include projects by Max Neuhaus, such as *Times Square* from 1992. The acoustic ecology and soundscape studies current includes the creative activities by Lidia Zielińska (such as *Soaked Music*, with children audience, narrator, conductor and tape, 1993; *Muzyczne pejzaże – wczoraj, dziś, jutro [Musical Landscapes – Yesterday, Today, Tomorrow]*, multimedia concert for children, 2011) and the research of musicologist Danuta Gwizdalanka.[386] Moreover, the 'Audiosphere Workshop' was established in 2009 at Wrocław University's Institute of Culture Studies to conduct interdisciplinary studies of, among other things, the soundscape of Wrocław.[387]

A soundscape is a certain kind of electroacoustic immersive form, a complex of sound phenomena, an audiosphere[388] or sonosphere of a particular place and time. When it comes to this current, musical productions range from field and open-air recordings to original works that use electroacoustic techniques to transform sound material, while invariably maintaining the recognisability of the source of the sound. Soundscapes may include sounds that are biophonic (that

384 The project has found its continuation in the activities of the World Forum for Acoustic Ecology. See: R. Murray Schafer, *Muzyka środowiska [Music of the Environment]*, translated by Danuta Gwizdalanka, *Res Facta* (1982), issue 9, p. 288.

385 Such practices were employed by Hildegard Westerkamp, author of electroacoustic works and outdoor performances.

386 See Gwizdalanka, *Strojenie trąb jerychońskich [Tuning the Trumpets of Jericho]*, *Ruch Muzyczny* (1987), issues 19, 20, 21, 22, and 24.

387 Cf.: http://pracownia.audiosfery.uni.wroc.pl/.

388 A term used, among others, by Maria Gołaszewska; See: Maria Gołaszewska, *Estetyka pięciu zmysłów [The Aesthetics of the Five Senses]* (Warszawa—Kraków: Wydawnictwo Naukowe PWN, 1997).

is, of flora and fauna), geophonic (non-biological sounds of nature and the elements), and anthropophonic (human and human-triggered sounds, including electronic).[389] Simulating or creating new soundscapes became possible owing to new recording media (related to field recordings) and playback media (hi-fi, surround equipment). This kind of music required a different kind of listening; Schafer calls it 'sharpened' (*clairaudience*).

One example of the first electroacoustic soundscape composed using the *musique concrète* technique is *Presque rien numéro 1* (1970) by Luc Ferrari.[390] At a similar time, the World Soundscape Project yielded a series of programmes called *Sound-scapes of Canada* (1974), an 'environmental radio' of sorts created according to an idea by Bruce Davis, using the radio medium for the direct transmission of natural soundscapes. The basis for Schafer's quadraphonic *Okeanos* (1971) (created in collaboration with Davis and Brian Fawcett) was formed by the recorded sounds of the sea and recitation of poetry. *North/White* (1973) for orchestra and snowmobile provides quite an emphatic illustration of the acoustic pollution of Canada's northern regions. In the *Second String Quartet Waves* (1976), Schafer used measurements of the level of the sea waves to determine sound pitches and time-phase lengths.[391]

One composer who has been combining recordings of ambient sounds with instrumental music since the early days of his creative activity is Krzysztof Knittel. In *dorikos* (1977), he adorned the euphonious sound of a string quartet with various recordings of the sounds of nature and civilisation; in *Cheap Imitations* (2008), the instruments held a dialogue with the sounds of a busy street. Knittel's four-disc album *The Four Seasons* (2010) consists of field recordings from which the composer constructed a sonic diary of sorts.[392] When it comes to Polish music, this genre is also represented by Lidia Zielińska (*Soaked Music*) and Marek Chołoniewski (*Wieliczka Salt Mine*, presented as a sound installation during EXPO' 2005). The characteristics

389 See: Bernie Krause, *Anatomy of the Soundscape*, *Journal of the Audio Engineering Society*, 2008, Vol. 56, issues 1–2; Bernie Krause, *The Great Animal Orchestra: Finding the Origins of Music in the World's Wild Places* (New York: Little Brown, 2012).

390 An anticipation of this trend could be seen in Walter Ruttmann's 1930 *Wochenende*.

391 Maksymilian Kapelański, *Mała historia ekologii akustycznej (1967–2005) [A Little History of Acoustic Ecology (1967–2005)]*, http://www.nowamuzyka.republika.pl/artykuly/teksty/kapelanski.htm.

392 Cf. Chapter 3.4.

of a soundscape are present in Kotoński's *Tierra caliente* (1992), composed from processed and edited sounds of nature (animals, insects, birds, avalanche, earthquake) and construction work (demolition of walls, shattering of windows), which he took from CDs containing special effects created for theatrical performances.

Close to soundscapes is a current straddling the line between classical and popular music – ambient,[393] initiated by Brian Eno, the creator of *Music for Airports* (1978). Ambient music is characterised by an extreme reduction of the melodic and narrative factor; it is suspended in space, with neither a clear beginning nor end. In contrast to the soundscape, it is intended to act as a background, not absorbing the listener's attention to a significant degree,[394] but subconsciously influencing the listener's mood and well-being.

1.5.7. On the antipodes of electroacoustic music – sound art

Owing to new technologies, it became possible to combine completely different, seemingly incompatible elements in art. This ubiquitous hybridisation also manifested in electroacoustic music, which had moved far away not only from traditional artistic forms and means, but also from traditionally-understood sonority. It came under the umbrella of performance and installation art, which at the end of the 20th century became strongly associated with new media. The term 'music' seems inadequate, even incompatible for encompassing the many different phenomena that have emerged within this field.[395] In the visual and performing arts, too, there have been works that are difficult to classify, with sound playing a key role in them, although it may be used in an entirely non-musical way.[396] Thus, a consid-

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393 Erik Satie is considered to be the anticipator of ambient. His *Musique d'ameublement* was intended to be a backdrop for everyday activities – music whose aim is not to rivet attention, but rather to set the mood.

394 The idea of music as a sonic wallpaper of sorts was for many, including Theodor W. Adorno, initially a manifestation of an escape from a sense of spiritual emptiness and 'intellectual inertia'. See Theodor W. Adorno, *O fetyszyzmie w muzyce i o regresji słuchania [On Fetishism in Music and the Regression of Listening]* [in:] Th.W. Adorno, *Sztuka i sztuki. Wybór esejów [Art and the Arts]*, translated by Krystyna Krzemińska-Ojak (Warszawa: Państwowy Instytut Wydawniczy, 1990).

395 See: Alan Licht, *Sound Art: Beyond Music, Between Categories* (New York: Rizzoli International Publications, 2007).

396 The ever more perceptile hybridisation of genres does little to render this easier. For instance, the *Photon Voice* project by Otto Piene, Elizabeth Goldring and Lowry Burgess in 1986 bears traits of site-specific art (it was carried out in the Mojave Desert), sculpture-installation (in the form of

erable area of art eluding the attempts at a holistic approach has emerged – self-referential art, whose essence lies in 'constantly redefining one's own paradigms'.[397]

The term *sound art* (sometimes used interchangeably with sonic art) was coined to classify the new phenomena in the 1980s. Initially used to refer to visual art exhibitions, it later referred to sound arts such as soundscapes, sound installations and sculptures, noise music, sound poetry, and many others. In the 1990s, another term – audio art – emerged in Polish music in order to encompass everything that touches on the issue of sound but goes beyond music.[398] Now this idea is central to one festival bearing this very name, organised since 1993, associated with experimental and post-modern electroacoustic music, multimedia, performances, installations, and other forms of art. In the words of Marek Chołoniewski, the artistic director of the said festival:

> Audio Art creates a new concept of sound source: according to it, it is formed by an object and a musical instrument in a specific space and time. Audio Art is a personal art: the composer, designer and performer unify the entire process of creating and performing the work.[399]

The terms 'sound art' or 'audio art' refer to the work of composers treating sound in new ways. Consequently, in the 1990s, a new branch of interdisciplinary theoretical reflection referring to a broad view of the new sound arts emerged: sound studies. Owing to the new media, music – and not only electroacoustic – was able to transcend the boundaries of sound, fuse with other modalities and become transaudible and transmedial. It is impossible to fully 'experience' and understand it by only using a single sense.

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spaced solar radiation sensors and a light-sound interface), live performance (that is, involving the artist's movement) and mediatised performance (that is, recorded and televised). When it comes to Polish art, examples of 'hybrid' creations may be found among the works of Andrzej Dudek-Dürer, a Wrocław-based media artist, composer and musician. The broad spectrum of his creative interests ranges from printmaking, painting, photography and sculpture to video, installation, environment and the construction of metaphysical instruments (metaphysical and telepathic activities, e.g. *Information-Disinformation* from 1976).

397 Krawczak, *Przestrzenie komunikacyjne performance art*…

398 Guzek, *Sztuka instalacji…*, p. 254.

399 See: http://www.audio.art.pl/.

PART TWO

The poetics and aesthetics of electroacoustic art

2.1. Key aspects of new media art – multimediality, interactivity, virtuality

Art associated with new media, including electroacoustic art, brought about a series of changes concerning all aspects of poetics and aesthetics: subject to change are techniques of composition, recording, and distribution, as well as artistic goals and the ontological status of works and the way they are received. The language and area of the musicological debate and interpretation is expanding, and a number of new issues and concepts carried over from the fields of computer science, mass communication and media theory are entering it. One must, at least partially, recognise the key aspects of this new situation, whereof the most important ones seem to be, in the context of electroacoustic music, those focused on sonority (Chapter 2.2), spatiality[400] (Chapter 2.3) and a certain kind of sensitivity (Chapter 2.4). Describing these new phenomena is not possible without explaining the constitutive features of digital electronic media: multimediality, interactivity and virtuality.

2.1.1. Multimedia – intermedia – hypermedia

A *multimedia* message is created by way of mixing different, typically auditory and visual forms, or layers of information (text, sound, image, and film) using electronics.[401] Here, the interaction of all the elements usually occurs in such a way that no clear and focused hierarchy may be established between them. Their integration is intended to increase the informational and aesthetical efficacy of the message by reaching the audience through different perception channels.

Similar artistic ideas guided the Romantic *correspondance des arts*, or Wagner's *Gesamtkunstwerk* concept[402] developed in relation to opera and musical drama. These ideas involved the coexistence and interaction of musical, theatrical, and poetic means, and more. Multimedia art *sensu stricto*, however, is not just about combining

400 See: Andrzej Miśkiewicz, *Brzmienie i przestrzeń jako podstawowe cechy wielowymiarowe obrazu słuchowego [Sound and Space as Basic Multidimensional Features of the Auditory Image]* [in:] *Kształtowanie i percepcja sekwencji dźwięków muzycznych [Shaping and Perception of Musical Sound Sequences]*, ed. Andrzej Rakowski (Warszawa: Wydawnictwo Akademii Muzycznej im. Fryderyka Chopina, 2002), p. 194.

401 The term 'multimedia' replaced the term 'mixed-media', the latter not requiring electronic technologies.

402 Cf. *Multimedia: From Wagner to Virtual Reality,* eds. Ken Jordan, Randall Packer (New York: W.W. Norton, 2002).

different art disciplines in a single work, but about using electronic media that are inherently non-artistic. Jacek Szerszenowicz, however, reminds us that the very idea of the correspondence of arts 'bridges the gap between contemporary orientation towards the audiovisual, the artistic practice of the romantics and the syncretic art of antiquity, when music formed a "triunity" with dance and poetry'.[403]

The term 'multimedia' was first used in 1966 to refer to Andy Warhol's performance, *Exploding Plastic Inevitable*, which constituted a combination of a rock concert, cinema projection and light play. At the same time Dick Higgins began to use the term *intermedia* for characterising the activities of the artists of the Fluxus movement.[404] New technologies, far from purely artistic means, were, in a certain sense, intermedia in nature by definition.[405] In the sense given to the term by Higgins, they were situated between art and 'non-art'.[406] In activities such as visual poetry, environment or happening, the modalities were closely and permanently linked, making up a non-separable entity. At the time, the message exhibited the characteristics of different art disciplines, locating itself, between them in a certain sense, hence the prefix 'inter-'. Ryszard Kluszczyński emphasises that the terms 'multimedia' and 'intermedia' emerge not so much from the combination of media arts, but, rather, from the media themselves. What matters here is the 'cognitive horizon' opened up by the work, not the means employed by the artist.

The multimediality and intermediality of the artwork is closely linked to the new features of artistic communication. Multimedia may be linear and passive in nature, but also – more typically – non-linear,[407] interactive, in which case one would speak of rich multimedia or

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403 Jacek Szerszenowicz, *Inspiracje plastyczne w muzyce [Plastic Inspirations in Music]* (Łódź: Akademia Muzyczna im. Grażyny i Kiejstuta Bacewiczów w Łodzi, 2008), p. 10.

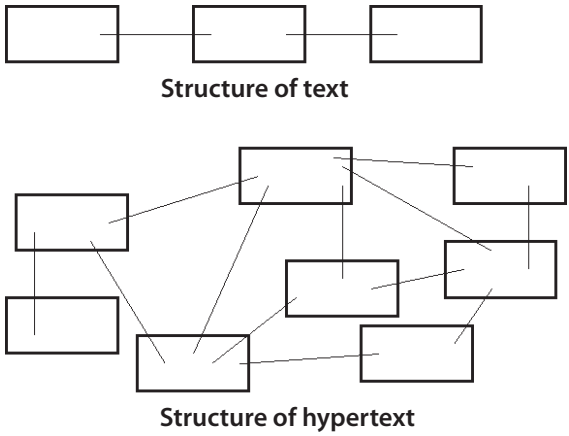
404 Dick Higgins, *Intermedia*, translated by Monika Zielińska and Tomasz Zieliński [in:] Higgins, *Intermedia i inne eseje [Intermedia and Other Essays]* (Warszawa: Akademia Ruchu, 1985), pp. 17–21.

405 Higgins was referring to the term 'intermedium' coined by the late 18th and early 19th century British poet Samuel Taylor Coleridge, and at the same time to Robert Rauschenberg's attitude of wanting to operate in the gap between art and life. See: *Intermedia. Enacting the Liminal*, ed. Hans Breder, Klaus-Peter Busse (Norderstedt: Books on Demand, 2005), p. 51.

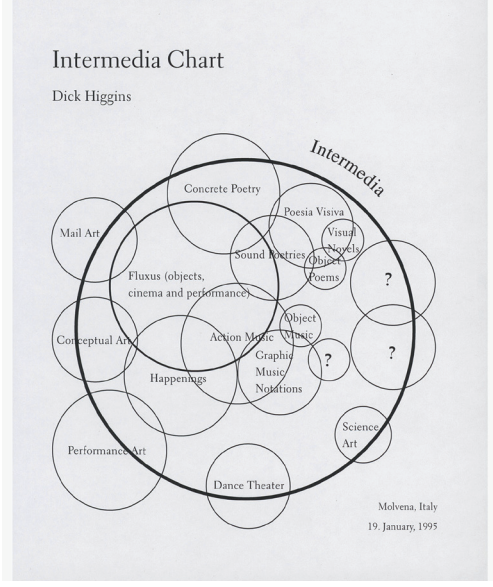
406 Grzegorz Dziamski, *Od syntezy sztuk do sztuki post-medialnej [From Synthesis of Arts to Post-media Art]*, *Estetyka i Krytyka*, 2009–2010, issue 17–18 (2–1), p. 42.

407 A newspaper or an encyclopaedia could be considered as non-linear media, and a computer hard drive and a computer game as non-linear media.

hypermedia, or multimedia that produce hypertexts.[408] In hypermedia, there is a shift away from the traditional, typical language-based way of expressing thoughts towards simultaneous thinking with images, colours and sounds. Due to this, the structure of a multimedia work can resemble a rhizome, being something that neither begins nor ends (e.g. installations or soundscapes).



Example 21. Text vs. hypertext



Example 22. Dick Higgins, *Intermedia Chart* (1995)

408 Cf. Chapter 1.5.3.

In intermedia, the synthesis, or, one should say, synergy of the inseparable layers of the message takes place at a deep level. Multimedia allow different kinds of content to be broadcast simultaneously in a single message, and the individual elements may be loosely connected, even *ad hoc*. Music may be employed to complement an image, but it can also oppose it to change the sense in which it is perceived. Using the products of different arts and artistic practices, one may 'disattach' information from its proper context and place it in another. At the metamedia level, one may then obtain a multiplicity and incoherence of media narratives.

The most important hypermedium that currently permits interactivity and mobility of content on a global scale is the Internet – the interconnection of all media into a seamless network of digital, electronic means of communication. It has seen the development of net art[409] and new cultural circuits, such as the practice of artists uploading their own works to freely accessible video portals, such as YouTube, MySpace, or Vimeo, or broadcasting live festival concerts via Internet links (e.g. during the Audio Art Festival[410]). Various network platforms collect, develop and disseminate art that is not only directly related to the network (multimedia performance, transgenic art, telematic art, bio-art, telerobotic art, etc.), but also a whole range of other types of new media art for which the Internet is only a secondary place of presentation and distribution.[411] As Piotr Zawojski points out:

> In addition to the incredible potential for the creation of new forms of art inherent to the nature of the network, such as software art, flash projects, hacktivism, networked interactive installations, browser art, digital Zapatismo, generative art, the Internet has already become an indispensable environment for documenting everything that happens in the art world.[412]

One case-in-point example of 'internet music' is the YouTube Symphony Orchestra project, whose members were recruited online. Over 3,000 musicians from 70 countries took part in the auditions.

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409 See: Ewa Wójtowicz, *Net art*, Rabid, Kraków 2008.

410 See: http://www.audio.art.pl/.

411 Ricardo Dal Farra, *Re-thinking the gap: electroacoustic music in the age of virtual networking*, http://www.ems-network.org/ems09/papers/dal_farra.pdf.

412 Piotr Zawojski, *Teoretyczne konteksty dokumentacji sztuki nowych mediów [The Theoretical Contexts of Documenting New Media Art]*, *Zeszyty Artystyczne*, 2008, issue 17, http://www.zawojski.com/2007/07/09/teoretyczne-konteksty-dokumentacji-sztuki-nowych-mediow/.

They published samples of what they could do via a YouTube channel. In 2008, as part of this project, the Google and YouTube commissioned Chinese film music composer, Tan Dun, to write a piece for orchestra – who named it *Internet Symphony No. 1 'Eroica'*. The project culminated in a concert at New York's Carnegie Hall in 2009, and, thanks to a live internet broadcast, was watched by 22 million viewers from two hundred countries simultaneously.

With time, the term 'multimedia' became the most popular and has, to some extent, absorbed the meanings indicated by the terms 'intermedia' and 'hypermedia'. Among multimedia, Nicholas Cook counts, for example, music videos, filmed productions of operas, even covers of record releases.[413] In fact, he considers the entirety of contemporary culture to be of a multimedia nature, and notes the problem associated with confronting different media in the very practice of discussing music.[414] In an aesthetic perspective this broad, multimedia are 'an area of contact between the analogue and the digital, linearity and non-linearity, historicity and actuality, dynamism and staticity, monochrome and multicolour, aesthetics and anaesthetics, simulation practices and mimetic-type practices'.[415]

In our day, the computer is the basic multimedium ('hypermedium'[416], 'metamedium'[417]), as it processes all content in the form of digitised data, so that it may, in a certain sense, become any other medium itself – a tool for reading texts, watching films, listening to music, or for composing, recording and distributing works of art. The computer has become a platform mediating in this creative work and transcoding the message from one medium to another. Owing to

413 Nicholas Cook, *Analysing Musical Multimedia* (Oxford: Clarendon Press, 1998), p. 23.

414 Ewa Schreiber, *Muzyka i metafora [Music and Metaphor]* (Warszawa: Narodowe Centrum Kultury, 2012), p. 101.

415 Piotr Witek, *Multimedia jako jeden z wariantów kulturowej gry w historię. Metodologiczne problemy „przedstawiania" przeszłości w epoce ekranów [The Methodological Issues of 'Representing' the Past in the Screen Age]* [in:] *Język @ multimedia [Language @ Multimedia]*, eds. Agnieszka Dytman-Stasieńko and Jan Stasieńko (Wrocław: Wydawnictwo Naukowe Dolnośląskiej Szkoły Wyższej Edukacji TWP we Wrocławiu, 2005), p. 367.

416 Piotr Zawojski, *Wewnątrz obrazów. Immersja zamiast iluzji? [Inside Images. Immersion Instead of Illusion?]* [in:] *Przestrzeń sztuki: obrazy – słowa – komentarze [Art Space: Images – Words – Commentaries]*, ed. Maria Popczyk (Katowice: Akademia Sztuk Pięknych w Katowicach, 2005).

417 Alan Kay, Adele Goldberg, *Personal Dynamic Media*, *Computer*, (1977), Vol. 10, issue 3, pp. 31–41; also [in:] *The New Media Reader*, ed. Noah Wardrip-Fruin, Nick Montfort, (Cambridge: The MIT Press, 2003), p. 393–404, http://www.newmediareader.com/book_samples/ nmr-26-kay.pdf.

the digital 'language' and manner of recording shared by image and sound alike, multimedia are characterised by a certain kind of transitivity of structures, a transcoding of one medium into another. This transitivity – also of 'old', analogue media into new media – and the transcendence of the message beyond a single channel of reception are linked to the phenomenon of transmedialisation and *convergence*.[418]

The correlation and transfer of signals from one modality to another offer new possibilities for artistic expression. Thus, within multimedia, music is absorbed into the visual arts, but also vice versa: media can visualise (multimedialise) music. Music, when brought to the digital domain, may be transformed directly – or, as McLuhan would say, 'extended' – for instance, into an image illustrating changes in loudness over time (waveform), changes in spectral structure (spectrogram), and much more. Such visualisation may occur in real time, in real time, allowing one to 'see' the sound, in a certain sense. The manner (algorithm) of these transformations may be modified and deliberately distorted, which is employed extensively in the arts, especially in VJ practices. At the same time, visualisations make it possible to analyse music on a completely different level (e.g. multidimensionally) and with hitherto-unattainable precision – something first exploited by spectralists. Currently, the vast majority of composers dabbling in electroacoustics use such techniques for creating music.[419] The visual representation of the various sound parameters displayed on the computer screen becomes an interactive graphic score of sorts.

2.1.2. Media couplings – interactivity

If the viewer is able to influence the final shape of an artwork – through electronic media – it becomes i n t e r a c t i v e. This feature is a key property of digital, convergent hypermedia, as it offers the possibility of a new kind of dialogue between the viewer and the work.[420] An interactive work is dynamic, mutable, non-linear and

418 In biology, convergence refers to the emergence of similar traits in different species resulting not from the species' relatedness, but rather the demands of the environment. See: Henry Jenkins, *Kultura konwergencji. Zderzenie starych i nowych mediów [Convergence Culture: Where Old and New Media Collide]* (Warszawa: Wydawnictwa Akademickie i Profesjonalne, 2007); According to Henry Jenkins, the convergence process is an alternative to the concept of digital revolution.

419 *Looking at the Sound* [chapter in] Peter Elsea, *The Art and Technique of Electroacoustic Music* (Middleton: A-R Editions, 2013), p. 35.

420 According to Antoni Porczak, interaction is understood as a dialogue held with a machine in real time. See: Antoni Porczak, *Interfejs, intermedia, interakcja, interpretacja [Interface, Intermedia, Interaction, Interpretation]*, http://porczak.art.pl/blog/?p=171.

open-ended (work in progress); it is not so much an object as a process of revision, a 'participatory interpretation'.[421] In the words of Ryszard Kluszczyński:

> Interactivity is a fundamental property of the overall process through which both the substantive and semantic status of art is reshaped. This process takes place by, among other things, separating the work from the artefact, as well as through the latter assuming the nature of hypertext.[422]

When confronted with new media, the hitherto-passive consumer of art is encouraged to co-shape its artefacts and becomes an interactor.[423] Although the artist remains the creator of the context, as well as the 'mediator'[424] and 'director' of the artistic setting, they forfeit some control over his work, which only takes its final shape upon interaction with the beholder.

Multidirectional electronic transmitters have the capacity for multilateral dialogue – the simultaneous reception, modification and redistribution of cultural artefacts – which, according to Denis McQuail, constitutes the essential difference between analogue technology (radio, film, television) and digital technology (computer, internet). The measure of interactivity, writes McQuail, is the response rate from the user to the sender's offering.[425] Through interaction activities, the roles of creator and viewer may even become equalised. In addition, more sophisticated projects using digital media environments, or assuming a causal response from the viewer, are able to banish intermediary interpretation[426] – electroacoustic music, performance art, and installation art require no instrument-wielding performers.

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421 Kluszczyński, *Sztuka interaktywna*…, p. 142.

422 Kluszczyński, *Film-wideo-multimedia*…, p. 100.

423 Jolanta Dąbkowska-Zydroń, *Multimedialna forma komunikacji – nowość czy kontynuacja? [The Multimedia Form of Communication – Novelty or Continuation?]* [in:] *Intermedialność w kulturze końca XX wieku [Intermediality in Culture at the End of the 20th Century]*, eds. Andrzej Gwóźdź, Sław Krzemień-Ojak (Białystok: Trans Humana, 1998), p. 126.

424 Myron Krueger, *Artificial Reality* (Reading: Addison-Wesley, 1983), p. 13, quoted in: Piotr Zawojski, *Ciało jako interfejs. O kilku (nie)przypadkowych sytuacjach, w których staję się (współ)twórcą [The Body as an Interface. On Some (Un)accidental Situations Where I Become a (Co-)creator]* [in:] *Media, ciało, pamięć. O współczesnych tożsamościach kulturowych [Media, Body, Memory. On Contemporary Cultural Identities]*, eds. Andrzej Gwóźdź and Agnieszka Nieracka-Ćwikiel (Warszawa: Adam Mickiewicz Institute, 2006), p. 261.

425 McQuail, *Teoria komunikowania masowego*…, p. 156.

426 Szwajgier, *Pułapka intermedialna*…, p. 136.

Their role may be entirely taken over by interactive media.

According to Marta Dziewanowska-Pachowska, interactive art requires the presence of five factors: movement (kinesthesia), action (participation), an interface, new media and a concept or context.[427] A feedback loop of sorts appears between the interactive work and the beholder-interactor[428] – the beholder simultaneously perceives the content or the course of the form and changes it. Both the technical and the personal aspects interact, so the experience of interactive art is self-reflexive – essentially, it may be an experience of oneself for the viewer. When the presentation and dissemination of a given work occur through the Internet, the boundaries between creators, distributors, and audiences become blurred, including on the social level (network interaction).[429]

An interactive artwork may become the subject of a 'dialogue' between man and machine. Thus, from a technical perspective, interactivity is the ability to detect, recognise, and respond to human behaviour. These behaviours may include physical manipulation, bodily movements or 'speech', verbal messages, and even changes in mental states (e.g. through encephalography). Inherent to interactivity are action, participation, and the involvement of the body. Interactive multimedia may create complex environments allowing one to explore the relationship between physical bodies and their representations that exist in digital reality.[430] These relationships often become central to the artist's aesthetic.[431]

A culture saturated with interactive artefacts is, according to Antoni Porczak, 'a guarantor of our impact on the environment, where biology and technology negotiate the terms of co-existence. Interactive technologies "stick" to us more and respond more

427 Marta Dziewanowska-Pachowska, *O interaktywności w sztuce multimedialnej [On Interactivity in Multimedia Art]*, *Aspiracje*, 2013, issue 1, p. 40.

428 Here, Kazimierz Krzysztofek uses the term *sendceiver*, combining the English words 'send' and 'receive'. See: K. Krzysztofek, *Status mediów cyfrowych: stare i nowe paradygmaty [The Status of Digital Media: Old and New Paradigms]*, *Global Media Journal – Polish Edition*, 2006, issue 1, http://www.globalmediajournal.collegium.edu.pl/artykuly/wiosna%202006/Krzysztofek-status%20mediow%20cyfrowych.pdf.

429 A good example of this is the net art project *GlobalMix* by Marek Chołoniewski. Cf. Chapter 3.5.

430 Camille Utterback, *Statement*, http://www.camilleutterback.com.

431 See: Piotr Zawojski, *Destrukcja versus wspomaganie ciała w cyberprzestrzeni. Przypadek Stelarca [Destruction versus Support of the Body in Cyberspace. The Case of Stelarc]*, *Kultura Współczesna*, 2000, issues 1–2.

effectively'.[432] Lev Manovich, on the other hand, believes that interactivity may be viewed from a completely different perspective – as a particular kind of misunderstanding between author and user, as the author, planning his work, does not always know the assumptions or intentions that a particular user will approach the work with. Thus, the *interactor* may not be called a co-creator. Oftentimes, a person who comes into contact with a work of new media art has no prior knowledge as to the work itself, of its functioning, or its artistic aims. 'Instead of collaborators,' writes Manovich, 'the author and the user are often two total strangers, two aliens which do not share a common communication code.'[433] Interacting with a work of art objectifies the process of association, ever so often deemed to be central to human thinking. The mental processes – reflection, problem-solving, remembering, associating – become externalised, reduced to one's choice of a link or following pre-programmed and objectively-existent associations, 'we are forced to take the structure of someone else's mind as our own'.[434]

The origins of interactive art go back to kinetic art, which breaks with the concept of a stable, immutable structure of the work, as well as that of the art of action – happenings, performances, and other artistic actions. Even then, the composers' openness to improvisation and chance, and, ultimately to the participation of the viewer, was evident. One might, therefore, look for a source of interactive art in Cage's work and in all kinds of experimental music; as pointed out by Michael Nyman:

> Experimental composers are, by and large, not concerned with prescribing a defined time-object whose materials, structuring and relationships are calculated and arranged in advance, but are more excited by the prospect of outlining a situation in which sounds may occur, a process of generating action (sounding or otherwise), a field delineated by certain compositional 'rules'.[435]

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432 Porczak, *Ciało jako switch [The Body as Switch]*, *Kultura Współczesna*, 2000, issues 1–2, http://porczak.art.pl/blog/?p=143.

433 Lev Manovich, *Kim jest autor? [Who is the Author?]*, translated by Mirosław Filiciak, *Kultura Popularna*, 2003, issue 1, p. 92.

434 Manovich, *Język nowych mediów…*, pp. 134–135.

435 Michael Nyman, *Muzyka eksperymentalna. Cage i po Cage'u [Experimental Music. Cage and Beyond]*, translated by Michał Mendyk (Gdańsk: Wydawnictwo słowo/obraz terytoria, 2011), p. 18.

Interactivity manifests especially in multimedia installation art. When creating an installation or other project, the artist may only anticipate the possible reactions of the interactors and create ready-made responses. The composition becomes a certain kind of programme that is able to react and even learn and develop, such as through the use of neural networks.

The question of interactivity in relation to artistic works is presently a frequently discussed aspect of new media works, but this applies almost exclusively to the visual arts. Where does electroacoustic music fall in this context? The issue of interactivity applies to sound art in at least two aspects: the relationship between the creator and the work (the studio phase of creative work on electroacoustic music makes use of interactive actions) and that between the work and its receiver (the listener influences the shape of the music during its presentation). Electronic media are also creating new models for performance and collective co-authorship. The potential for musical interaction emerged as soon as advances in technology made it possible to produce and process sounds using a variety of digital devices.[436] This feature of multimedia is already being exploited at the stage of composing electroacoustic music, created owing to the interactivity of sonic electronic media – electrophones such as synthesizers and samplers. Creative ideas are born through interaction with the media, not uncommonly by way of creative improvisation. The sonic possibilities of the medium used may therefore inspire the composer and influence the shape of their artistic expression. As US artist Camille Utterback notes, interactive systems 'determine the grammar of interaction with digital media and, in effect, enable the creation of meanings'.[437]

Digital media offer precise control over virtually every aspect of the sound, during the composition phase (studio work) and the live performance alike. Improvisation or fully-planned actions on the electrophones may thus be carried over to the concert setting. In the live electronics current, the interactor is the performer, as every electronic instrument is an interactive transmitter.[438] As a particular

436 One may hardly speak of interactivity in relation to analogue sound technologies. Initially, working with them was a highly abstract activity, and therefore primarily consisted in experimentation.

437 Utterback, *Statement*…

438 Interactivity permits many installations to be treated as an instrument of sorts. In relation to interactive works, Kluszczyński distinguishes several types of strategies: of instrument (instrumental interface), archive (database), labyrinth (hypertext), rhizome (cybertext), system (closed technological system), network (network of relationships), and spectacle (event). See: Kluszczyński, *Sztuka interaktywna*…

manner of shaping sound matter, has therefore been present since the advent of electrophones and electroacoustic music. However, the meaning of 'interactivity' is then partially devalued. In this broad understanding, music would always be an interactive sound art – for the performer it is 'interactive' to play the instrument and to communicate with fellow performers, but also with the creator and the audience. The use of the term in such a context comes across as out of place and inconsistent with its original meaning.

With the advent of interactive digital devices, music has entered a level of multifold media intermediation, present at several stages of a given piece's existence. The creator's contact with the matter of the work, the acoustic concretisation, as well as its reception, may all be mediated. The component enabling electronic media to communicate interactively with one another and their users is the interface.[439] It acts as a certain kind of translator of human actions into data, which is then processed by electronics, creating a 'surface of contact',[440] connecting the real world with that of the media. Owing to this, it enables the creation of the illusion of the user's presence in the digitally created space. The interface, as a physical and sensory space between human and machine, replaces face-to-face communication with inter-face communication. Communication phenomena such as medialabs or intercontinental videoconferencing are emerging, giving rise to situations of a kind of interactive perception (Antoni Porczak calls it 'operational perception'[441]). Creators treat interfaces both as a practical and a conceptual artistic challenge. They have become a fundamental aesthetic form of digital art,[442] which is why Steven Johnson, just like Peter Weibel, uses the term 'interface culture'.[443] Ryszard Kluszczyński, taking it one step further, sees in the new unified media a potential for 'transcultural interfaces'.[444]

439 The notion of interface is closely related to the theories by Lev Manovich, who almost equates new media with new interfaces. He also notes that the interface itself becomes a representation.

440 Brenda Laurel, *The Art of Human-Computer Interface Design* (Reading: Addison-Wesley, 1990), p. 12.

441 Porczak, *Medialna grota (instalacje interaktywne) [Media Grotto (Interactive Installations)]* [in:] *Intermedialność w kulturze końca XX wieku*…, p. 308.

442 Søren Pold, *Interface Realisms: The Interface as Aesthetic Form*, *Postmodern Culture*, 2005, Vol. 15, issue 2.

443 Cf. Weibel, *The World as an Interface*…, pp. 343–351 and Steven Johnson, *Interface Culture: How New Technology Transforms the Way We Create and Communicate*, Basic Books, New York 1997.

444 Kluszczyński, *Paranoidalne zwierciadła [Mirrors of Paranoia]* [in:] *Media, ciało, pamięć*…, p. 298.

In electroacoustic music, the function of interactive sound interfaces is fulfilled by electrophones, effects processors, and, above everything else, by computer software. These devices are used at every stage of a sound project's existence: its creative conception and pre-composition (recording analysis, algorithmisation), studio production (synthesis, sound processing), presentation (interface-instruments), then distribution and reception (mediatisation, web publication, the work's functioning in cyberspace). In multimedia, installation and performance art, sound interfaces may be touch panels, motion and light sensors, inductive antennae, and much more. These media are able to assume the most diverse of forms and shapes, constituting an object-work of art themselves.

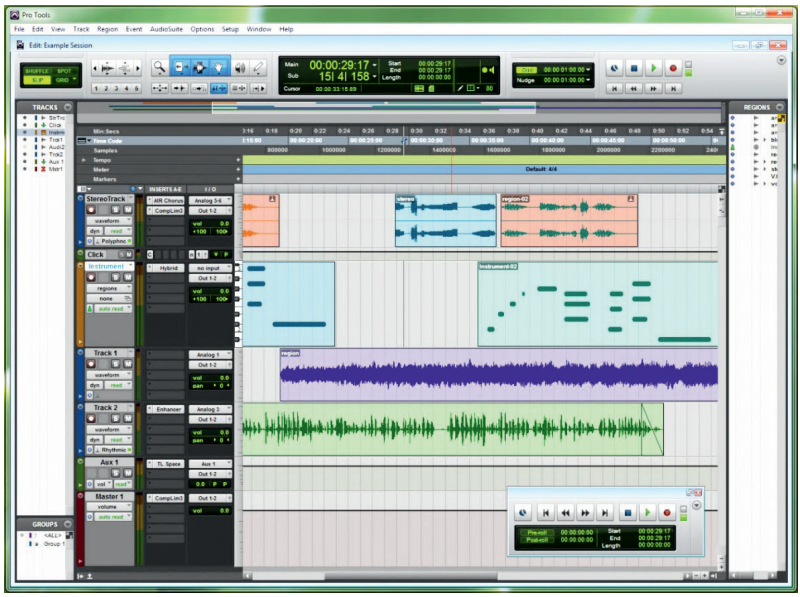
Every electronic instrument is a hardware sound interface in its own right – it allows the user to extract and 'control' the sound. New computer media are able to move the function of various instruments into the domain of graphical virtual interfaces. Such software instruments, usually in the form of VST plug-ins,[445] are able to simulate their analogue prototypes. Moreover, they are much more convenient to use, as they fully integrate into the environment of the platform they are controlled by. Everything the creator has access to – clips of recordings, individual sounds, effects – passes through the interface of the operating system. It would be difficult to imagine today's electroacoustics without specialised interfaces or software. With their graphical interfaces, these virtual musical instruments integrate auditory experiences with the visual and tactile. Navigation and manipulation may then take place via keyboard, MIDI controllers, mouse, or contactless means. Such technical solutions are a manifestation of the desire to explore new ways of controlling sound and musical performance.

Studio processing frames the sound not unlike a camera does with the image. As early as the 1970s, Hugues Dufourt, a composer-philosopher associated with spectralism, noted that the technologies for representing sound optically – from the spectrograph to the computer – enable precise intervention into the detail of an acoustic wave and make minute changes to it.[446] This is why the computer and software equipped with advanced graphical interfaces (GUIs) have become a fundamental tool for working with electroacoustic music.

445 Cf. Chapter 1.2.

446 Hugues Dufourt, *Muzyka spektralna [Spectral Music]* (1979), quoted in: Jan Topolski, *Widma i czasy [Spectres and Times]* (Warszawa: Wydawnictwo Krytyki Politycznej, 2012), p. 14.

According to the *What You See You Get* rule, actions on graphic objects constitute a direct representation of the manipulation of sound. This way, free intervention is possible not only in individual fragments of music, but also in selected registers, allowing one to 'sculpt' the sound spectrum.[447]



Example 23. The graphical interface of ProTools, one of the most popular digital audio workstations

The environments and computer tools[448] used for creating music have become spaces of virtual acoustics, simulating real sound conditions, so that the creator is able to keep track of the sonic results of their work in real time. According to Krystyna Wilkoszewska, concepts such as 'immateriality', 'digitalisation' or 'virtualisation', most commonly derived from the field of cutting-edge technologies, transcend the expansiveness of digital media and constitute an entirely new, postmodern 'dispersed subjectivity'.[449] The artist's navigation in the

447 Cf. spectrograms in Chapters 3.1. and 3.2.

448 Michael F. Schober, *Virtual Environments for Creative Work in Collaborative Music-making*, *Virtual Reality*, 2006, Vol. 10, issue 2, pp. 85–94; Byungdae Jung et al., *Incorporating Co-presence in Distributed Virtual Music Environment* [in:] *VRST'00: Proceedings of the ACM Symposium on Virtual Reality Software and Technology* (New York: ACM Press, 2000), pp. 206–211.

449 Wilkoszewska, *Estetyka nowych mediów* [in:] *Piękno w sieci...*, p. 8.

world of numerous different modalities is facilitated by the *computer*. Owing to its interactive interfaces at the 'production' stage, physical differences between media may be, in a certain sense, abolished. Whether the artist is working with visual, textual or audio material, digital technologies treat all data as a unified, digitised stream subjected to the same operations. Indeed, the entirety of the auditory, visual or multimedia message may be represented by a binary code, i.e. as a sequence of ones and zeros grouped into bits of information. The presentation of such broadcasts may thus be carried out indirectly, i.e. streamed – 'live' or 'on-demand' – via the web. The interface then becomes a passageway between the real world and the virtual world.

2.1.3. Through the glass of technology – virtuality

New media break the linear and rational train of thought,[450] change the way we perceive the world, and have unlimited possibilities for simulation and creation. They not only depict, but potentially shape and create multi-sensory environments close to the world one knows from everyday experience, or completely different, new, abstract ones. This becomes a valuable trait in the context of art, which, ever since its beginnings, could not have had the aim of merely representing reality (per the idea of *mimesis*). An opportunely-shaped message is able to direct, deceive, and even trick the perception of the recipient. As one perceives the world by being part of it, it means that taking reins of their senses may create the illusion of perceiving something real, and that virtual realities can be created.

The term 'virtual' may refer to an illusion created in the human mind or a simulation created with the use multimedia, but so realistic that it appears real (hence the term 'virtual reality'). A variety of technologies – screens, projectors, goggles, headphones, speakers, joysticks, touch panels, gloves, costumes... – are used as interfaces to 'extend' the human senses. They allow one to navigate and modify the computer-generated, audiovisual environment. It combines auditory, visual and, not uncommonly, tactile messages in order to heighten the sense of immersion in the virtual world, which is to say, of being 'inside it'. The multi-media perspective of such a message may be continuously updated according to the user's point of view at a given time. Recipients experience seemingly-contradictory sensations – an intense impression of realism and, at the same time, a feeling of liberation from the domination of reality itself.

450 Wilkoszewska, *Estetyka nowych mediów*…, p. 9.

Those types of messages that are located only in digital space, cyberspace, are characterised by virtuality *sensu stricto* and are therefore deprived of the material sphere. Moreover, such a message is characterised by digitality, polysensoriality, interactivity and immersiveness. Antoni Porczak describes it 'as a simulated reality, adapted to be transformed by the user in real time, in which one may move (in a certain sense) both bodily and mentally (in a multi-sensory manner: kinesthetics, vision, hearing, or touch) while being able to immediately perceive the effects of their own interactions with the environment'.[451]

Reality simulation in VR (Virtual Reality) environments has been used extensively for military (flight simulators) and medical (virtual surgery) ends; it has also been associated with the arts almost since its very beginnings. Myron Krueger, scientist and artist, who from 1969 onwards initiated projects combining the achievements of art and computer science (e.g. *Glowflow* from 1969, using Moog synthesizer sounds and based on the dislocation effect, and the audiovisual installation mazes, *Metalplay,* from 1970 and Psychic Space from 1971), is considered to be an anticipator of virtual reality. The first virtual interactive spaces, 'sensitive' to the movement of the body, were created by Krueger in the mid-1970s, including *Videoplace* (1975), in which participants, who were actually located at a distance between one another, were made to feel that they were right next to one another, and that they could 'touch' or manipulate one another's representation on screen, thus creating 'living graffiti'. Similar attempts at employing virtual environments in art were made at the California Institute of Technology by David Ema (in *Aku* from 1977 etc.). The most prominent experiments in this field took place in the 1980s and 1990s, when digital technologies became widespread.

The term 'virtual reality' is attributed to computer scientist and musician Jaron Lanier, and the first complete art projects were created by Jeffrey Shaw, including *Legible City* (1988), *Virtual Museum* (1991), and *Golden Calf* (1994). The acceptance of virtual reality as a new artistic medium came in 1993, with the exhibition *Virtual Reality: An Emerging Medium* at the Guggenheim Museum in New York.[452] The

451 Porczak, *Wirtualny dotyk [Virtual Touch]* [in:] *Estetyka wirtualności*, ed. Michał Ostrowicki (Kraków: Universitas, 2005), p. 30.

452 At the New York exhibition, virtual reality was accessible via computer. All works, such as Jenny Holzer's production *Bośnia* (1993), could be viewed on computer screens, and thus the entry into the world created by the artist was itself virtual in nature.

1990s also saw the beginning of Maurice Benayoun's artistic activities, combining virtual reality with the web (*Is God Flat* from 1994, *The Tunnel under the Atlantic* from 1995 and *World Skin, a Photo Safari in the Land of War* from 1997).

Research in the field of virtuality is carried out owing to things like the integration of art and technology.[453] This was the case with the CAVE (*C-Automatic Virtual Environment*) system, developed at the Electronic Visualisation Laboratory of the University of Illinois at Chicago and presented in 1992. Three years later, Canadian Charlotte Davies showed her first work allowing viewers to immerse themselves in the world of the artist's creation – *Osmose* (1995). Virtual environments for three-dimensional, spatial sound control are built by Florent Berthaut (the creator of spatial 'widgets' representing acoustic waveforms), Jared Bott,[454] and Leonel Valbom.[455] Virtual interfaces as tools for composition visualising sound and its characteristics are created by Richard Polfreman.[456]

In the early 1990s, with the efforts of the creative group Fakespace Music, the Soundsculpt Toolkit was created – a virtual software interface allowing one to communicate with graphical elements of virtual reality via a sound signal. The first virtual audiovisual landscapes that were created with it (e.g. *Vacuii*) were presented during Interactive Entertainment Hall in Siggraph'95. The Soundsculpt system was developed both for the ends of editing work and 'live' music performance. Jaron Lanier's late 1990s projects associated with his group Chromatophoria also aimed to employ traditional and virtual instruments in concert.

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453 Teemu Mäki-Patola, Juha Laitinen, Aki Kanerva, Tapio Takala, *Experiments with Virtual Reality Instruments* [in:] *Proceedings of the International Conference on New Interfaces for Musical Expression (NIME05)* (Vancouver: BC, 2005); Richard Porcher et al., *Sutoolz 1.0 alpha: 3D Software Music Interface* [in:] *Proceedings of the 2002 International Conference on New Interfaces for Musical Expression* (Dublin: Medialab Europe, 2002); Axel G.E. Mulder, *Design of virtual three-dimensional instruments for sound control* [Doctoral thesis] (Burnaby: Simon Fraser University, 1998).

454 Jared N. Bott et al., *One Man Band: A 3D Gestural Interface for Collaborative Music Creation* [in:] *2009 IEEE Virtual Reality Conference*, IEEE, Lafayette 2009, pp. 273–274, http://www.eecs.ucf.edu/~jjl/pubs/bott_final.pdf.

455 Leonel Valbom, Adérito Marcos, *An Immersive Musical Instrument Prototype*, *IEEE Computer Graphics and Applications*, 2007, Vol. 27, issue 4, pp. 14–18.

456 Richard Polfreman, *FrameWorks 3D: Composition in the Third Dimension* [in:] *NIME 2009: Proceedings of the 9th International Conference on New Interfaces for Musical Expression* (Pittsburgh: Carnegie Mellon University, 2009), pp. 226–229.

Virtual environments determine new ways of feeling and perceiving one's own body, creating a sense of being present in another world, a feeling that one may transcend physical limitations. They allow the interactors to 'dive' into a multimedia space to the point of losing their senses and taking the simulation for reality. This is referred to as *immersion*.[457] The way in which the sense of realness and immersion simultaneously intersect remains an open question of virtuality research.[458]

In electroacoustic music, the issue of virtuality relates to at least a few matters, above all: virtual instruments and editing software,[459] virtual acoustic spaces,[460] and the manner of recording and distribution.[461] Electroacoustically induced sound – no matter if electronic or acoustic, but reproduced through loudspeakers – may always be considered virtual, as it has no direct reference to a real sound source, and constitutes an acoustic *simulation*. Thus, the power of electroacoustics lies primarily in the enormous possibilities for creating artificial and hybrid spaces. Here the composer can deceive the listener no unlike an illusionist – after all, within the framework of the electroacoustic, there is a certain kind of inconsistency between the actual performance space and that imposed in the work. Thus, electronic media become a bridge between real and virtual acoustics.[462] In the digital world, analogue artefacts are dematerialised. In electronic media, sound does not exist in the physical sense, as oscillators and digital converters are both its source and carrier. Due to this, its processing is also abstract, as it is based on binary code. Electroacoustic creations could, therefore, be considered virtual music, and synthetic timbres as sonic simulacra.

As already pointed out by Jean Baudrillard, the simulations and simulacra created within the sphere of new media have become one of the basic epistemological figures of modernity. Łukasz Guzek notes that it is in the sphere of media that one may best see how 'art first

457 Cf. Chapter 2.4.4.

458 Michael Heim, *The Metaphysics of Virtual Reality*, (New York et al.: Oxford University Press, 1993), p. 127.

459 Cf. Chapter 1.2.8.

460 Cf. Chapter 2.2.

461 One setting combining the idea of cyberspace with that of VR, limited to the computer screen, is the virtual world of Second Life, which is sometimes used as a venue for the presentation or even sale of digital artworks.

462 John P. Young, *Networked Music: Bridging Real and Virtual Space*, *Organised Sound*, 2001, Vol. 6, issue 2, p. 107.

loses its aura and then becomes a simulacrum'.[463] Electroacoustics is capable of faithfully copying natural sounds, simulating them, and creating new ones. Krzysztof Szwajgier expresses a similar view:

> One could hardly ask for a better example of Baudrillardian simulacra than that provided by the electronic world. One can materialise the sounds of noise, percussion, harpsichord, piano, string sounds with slow or fast attack, as well as an infinite number of other types and variants of these. [464]

In electroacoustic music, therefore, a blurring of the boundaries between reality and simulation virtuality may occur, also when it comes to the presentation of the work. Furthermore, owing to new media, it is now possible to interact with the work either in physical reality or virtually, e.g. through mediatised artefacts. The new form of artistic presentation:

> Rejects the fundamental tools of sensory perception in favour of cognition *via electronica*. This kind of perceptual *modus* renounces direct visuality as a central system in our cognition, shifting the centre of gravity towards the illusiveness created by new-media systems of reference.[465]

Owing to the conversion of all data into digital code, music is liberated from the confines of traditional means of recording, capturing, and distribution. The browser window is able to replace both a wall in an art gallery and a concert stage. The message, existing in the form of a digital file stored on a computer hard drive, may be read as a Baudrillardian simulacrum – a copy and an original simultaneously. Such an artefact, or record of artistic activities, may be multiplied and distributed indefinitely by posting on a website or uploading in files. The distribution of cultural artefacts – texts, photos, films, or music gaining virtual digital form – is increasingly making use of the web and social media, which gives it the potential to revolutionise forms of cognition.[466] New media utilise *hypertexts*, making their message

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463 Guzek, *Sztuka instalacji…*, p. 190.

464 Szwajgier, *Klawiatura jest matrycą [The Keybord is a Matrix]* [in:] *Warszawska Jesień '10. 53. Międzynarodowy Festiwal Muzyki Współczesnej, 17–25 września 2010 [Warsaw Autumn '10. 53th International Festival of Contemporary Music, 17–25 September 2010]*, [programme book], http://www.warszawska-jesien.art.pl/wj2010/program/utwory/98489430.

465 Konik, *Wirtualność jako rehabilitacja iluzji…*, p. 79.

466 Cf. Jan Pleszyński, *Wartości epistemiczne mediów tradycyjnych i nowych [The Epistemic Values of Traditional and New Media]* [in:] *Komunikowanie (się) w mediach elektronicznych...*, p. 257.

reflexive – one could say that it is only the beholder's interaction with the hypertext transitorily turns it into a text. Such works materialise in the course of actualisation and are not tantamount to the results of the artist's creative efforts.

Interactivity and virtuality, giving new media an edge over old media, may relate to various aspects of the work, including the hardware and software interfaces that define how a composer works with sound material. It is therefore not only about perception, but also about the artist's new situation in general: the creative process, the reception, and the work itself, which is no longer an artefact, but rather a process.[467] Kluszczyński emphasises, that in traditional art forms:

> From the perspective of the artist/broadcaster, text is a tool of transmission, not interaction. Indeed, at the end of the reading process, the meaning of the work (text) awaits its discoverer and its hitherto hidden totality – the product of the artist – emerges. On the other hand, hypertext, a multi-level and multi-element structure does not determine or privilege any direction of perception (or, accordingly, understanding).[468]

This journey through the structure of hypertext is known as 'navigation'.

The phenomenon of virtuality contravenes the traditional model of separation between the real and the artificial, or, like in the case of immersion, supplants reality in favour of simulation and fiction. During a concert, the listener may not be aware whether they are listening to live music or a recording, or whether the timbre they hear came into being naturally or was generated artificially. This situation may be called – to borrow the expression from Kluszczyński – the 'liquid identity' of sound.[469]

2.2. Electroacoustics and new sonority – from noise art to synthetic timbres

The developments shown by the European musical literature of the last few centuries demonstrate that interest in the timbral aspects of sound has grown at a slow, yet steady pace. In the latter half of

467 Wilkoszewska, *Od kontemplacji do interakcji [From Contemplation to Interaction]* [in:] *Odłamki rozbitych luster. Rozprawy z filozofii, kultury, sztuki i estetyki ofiarowane Pani Profesor Alicji Kuczyńskiej, [Shards of Broken Mirrors. Dissertations in Philosophy, Culture, Art and Aesthetics Offered to Mrs. Professor Alicja Kuczyńska]* ed. Iwona Lorenc (Warszawa: Wydział Filozofii i Socjologii Uniwersytetu Warszawskiego, 2005), pp. 331–340.

468 Kluszczyński, *Internet – nowe terytorium ekspresji…*

469 Kluszczyński, *Społeczeństwo informacyjne…*, p. 43.

the twentieth century, the structural and sonic features of a musical work finally attained equal importance. The interest in sonority in the broad sense, which intensified in the 1960s, that is, the decade of sonorism, was triggered by, among other things, electronic music. As early as 1960, Józef Patkowski emphasised that 'the basic impulse driving musical experimentation was the desire to obtain sounds with new sound qualities and timbre'.[470] When it comes to this, new sound media have exposed composers and artists to a limitless range of possibilities. At the same time, the sonic quality aspects have become the area of greatest difference between traditional (acoustic) and electronic music: if one is able to somehow aurally distinguish one from the other at first contact, it is in the perspective of sound and timbre. Not uncommonly, contemporary electroacoustics finds fulfilment in the play between the sonically recognisable – the natural, and the unfamiliar – the transformed or synthetic.

2.2.1. Sound, sonic qualities, timbre – definitions, typologies, and methods of description

The 'sonic quality' is the entirety of all the characteristics of a given sound. Timbre is a narrower concept, but, along with pitch, duration and volume, it constitutes a fundamental sensory characteristic of the tonal quality of a sound;[471] it enables one to distinguish sounds originating from different sources, notwithstanding their equal frequency, intensity and duration.[472] Furthermore, timbre is a property that is not quantitative, but, rather, a multidimensional one, may relate to various characteristics of sound, and its relationship to the physical aspects of sound can be complex and far-reaching. First and foremost, it depends on the number, type and intensity of the component tones of the harmonic spectrum[473] and on how these tones rise and fall.[474] As early as the 19th century, Hermann von Helmholtz posited that

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470 Patkowski, *Perspektywy muzyki elektronicznej [Perspectives on Electronic Music]* [in:] *Horyzonty muzyki...*, issue 11, p. 1.

471 Murray Campbell, *Timbre* [entry in:] *The New Grove Dictionary of Music and Musicians*, Vol. 25…, p. 937.

472 *American Standard Acoustical Terminology*, American Standards Association, New York 1960, p. 45.

473 The spectrum of sound is the sum of its components – the tones. It is usually presented as a chart showing the intensity level against the frequency of the individual components of the sound. A characteristic feature of the oboe's sound, for instance, is the low intensity of the even components, while for the clarinet it is the odd components.

474 Oleszkowicz, *Muzyka – elektronika – informatyka*…, p. 56.

the brain perceives a sound wave as a superposition of sinusoidal waves of different frequencies, i.e. that, by differentiating timbre, one's auditory perception 'examines' the spectrum of sound.[475] In the broadest of terms, sounds containing few harmonic tones are usually perceived as flat and dull, while those saturated with a large number of harmonic tones are described as penetrating, bright, sharp, and metallic. The sonic quality, therefore, has a certain kind of spectral energy, what is metaphorically called timbre 'richness'.[476]

One element strongly impacting the perception of timbre is the shape of the transient[477] parts of the sound (initial strums, beats, etc.), which is why, apart from the spectrum, timbre is affected by articulation (the way vibrations are excited) and changes over time – the loudness envelope, i.e. the rate of rise and fall – as well as pitch. The sounds are, therefore, dynamic – they are different at the beginning and during the fade-out.

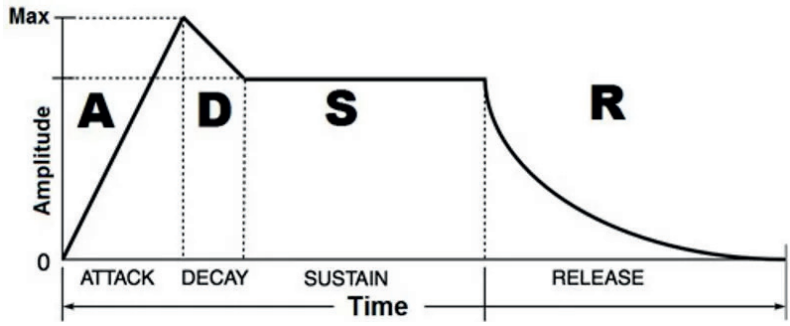
The perception of timbre is further determined by the sonic context (the influence of one timbre on another), function (the meaning of sound as a signal), as well as acoustic space and the manner of identifying the source.

Loudness and pitch are usually the dominant impression qualities. Timbre, on the other hand, is treated as a subordinate quantity, most commonly associated with all the other characteristics that elude easy definition. Thus, attempts to develop a theory regarding the classification of timbres, including synthetic ones, were made by many researchers. As early as the end of the 1960s, in his treatise on the morphology of sound, Pierre Schaeffer introduced terms

475 See: Hermann von Helmholtz, *On the Sensations of Tone as a Physiological Basis for the Theory of Music*, Longmans, Green, and Co., London—New York 1895, pp. 49–65, https:// archive.org/stream/onsensationston02helmgoog#page/n5/mode/2up.

476 Attempts to capture this feature in a measurable way were made by a Polish acoustician, Marek Kwiek. While studying the properties of strings and vibrations, he noticed that the amplitudes of the successive components of the sound he was studying naturally decreased by 6 dB per octave. Thus, Kwiek called the timbre under study, as well as the timbre of sounds exhibiting similar properties, the natural timbre. When the drop in component amplitudes was less than 6 dB per octave, he defined the timbre as strained, and when it was greater than 6 dB per octave, as mild. See: Kwiek, *Akustyka laboratoryjna*, cz. 1: *Podstawy akustyki teoretycznej, [Laboratory Acoustics. Part 1, The Fundamentals of Theoretical Acoustics]* (Poznań: Państwowe Wydawnictwo Naukowe, 1956); David L. Wessel, *Timbre Space as a Musical Control Structure* (Paris: Ircam, 1978), p. 1.

477 Transients are known as non-steady states, or short-lived changes to the internal structure of sound that are present in any acoustic phenomenon.



Example 24. Diagram of the timbre-shaping volume envelope (for keyboard instruments)

including: mass (pitch), matter (timbre) and form (loudness envelope, dynamic shape of sound, rising, falling and resounding phases).[478] Jan Frederik Schouten, on the other hand, hypothesised that these elusive characteristics of sound are determined by at least five acoustic parameters: the degree of 'noisiness', the spectral envelope (spectral changes), the loudness envelope, formant[479] and fundamental tone shifts, and intonation.[480]

Music theory, and, by extension, the interpreting artist, have always struggled with a lack of objective terms defining the purely sonic qualities of sound.[481] However, the practice of electroacoustic music has forced sound directors and artists alike to develop and use a kind of sociolect (or jargon, even) and to constantly search for new terms for musical sounds.

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478 Cédric Maridet, *Pierre Schaeffer and the Theory of Sound Objects* [in:] *SM4143. Sonic Arts & the History of Sound and Noises,* 2006, p. 8, http://sweb.cityu.edu.hk/sm4143. Also: Schaeffer, *Traité des objets musicaux*...

479 A formant is an especially emphasised frequency range of the spectrum of a composite sound. See: Tomira Rogala, *Próba wyznaczenia podstawowych kategorii opisowych barwy dźwięków formantowych [An Attempt to Determine the Basic Descriptive Categories of Timbre of Formant Sounds]* [in:] *Studia nad wysokością i barwą dźwięku w muzyce [Studies on the Pitch and Timbre of Sounds in Music]*, ed. Andrzej Rakowski (Warszawa: Wydawnictwo Akademii Muzycznej im. F. Chopina, 1999), pp. 170–204.

480 Jan Frederik Schouten, *The Perception of Timbre* [in:] *Reports of the 6th International Congress on Acoustics*, T. I (GP), ed. Yutaka Kohasi (Tokyo: Maruzen, 1968), pp. 35–44.

481 For this reason, among others, traditional musical analysis usually does not focus on the results, but, rather, on the causes of the sound: its structure or textural formations.

Timbre, not unlike expression, cannot be described to a satisfactory degree by a single numerical value. Thus, a wide range of metaphorical terms are used to *describe synthetic timbres*, e.g. a 'warm timbre' is one with a higher content of low-pitched components, a 'bright timbre' indicates a high content of high-pitched components, and 'dark timbre' means a low content of high-pitched components. With this type of subjective definition of timbre, a semantic description is usually used, with characteristics being assigned to the sound according to a fixed set of parameters, with the aid of adjectival terms. It is even possible to differentiate based on the similarity to the sounds of vowels. A popular variation of the word-based description of sound qualities is a method founded on a semantic differential referring to a bipolar scale of antonyms, popularised in the second half of the 20th century. It is also possible to reduce such a description to a unipolar scale by varying the intensity of a feature, as it is done for loudness. In his *Barwa solfeżu*, Andrzej Miśkiewicz lists a number of terms, constituting antonyms delineating the semantic differential scales, used for the parametric description of timbre (with their antonyms on the bipolar scale given in parentheses):

- shine (shiny – matte)
- roughness (rough – smooth)
- warmth (warm – cold)
- intelligibility (intelligible – blurred)
- formant quality (formant-rich – spectrally balanced)
- depth (deep – shallow)
- brightness (bright – dark)
- unpleasantness (unpleasant – pleasant)
- proximity (near – far)
- sharpness (sharp – mild)
- clarity (clear – hazy)
- spatiality (spacious – compressed)
- vocalicity (formantness)
- hardness (hard – soft)
- fusibility (fusible – diffuse)
- aliveness (alive – dead)
- cleanliness (clean – dirty)
- sonority (sonorous – deaf)
- density (dense – thin)
- intimacy (intimate – unfamiliar)
- roundness (round – angular)
- carrying power (powerful – not powerful)
- size (large – small)
- fullness (full/rich – empty/sparse)
- piercingness
- tonal balance
- width (wide – narrow).[482]

482 Andrzej Miśkiewicz, *Solfeż barwy II [The Solfège of the Timbre II]* (Warszawa: Wydawnictwo Akademii Muzycznej im. F. Chopina, 1991).

These terms, as well as the various combinations thereof – although metaphorical and ambiguous – have always found use in musical description and analysis, in the work of acousticians and sound directors, in psychoacoustic research, and in other fields. They have even become a certain kind of dictionary of sound interpretation.

Examining the problem from the perspective of cognitive science, Marcin Strzelecki points out that 'timbre is a feature distinguished and recognised, according to the schema theory, as a certain quality in a hierarchical system of musical knowledge'.[483] Based on psychoacoustic studies, all sound characteristics may be scaled by assigning them numerical values expressing their intensity.[484] In such descriptions, one-dimensional scales (measuring a single attribute of the timbre) and multidimensional scales (quantitative timbre description),[485] as well as graphical representations of the timbre parameter using a graph (the timbre thus described is a vector quantity) may be used. These new methods for analysing and imaging sound, its spectrum, and its loudness envelope, are becoming a tool for musical analysis that finds use increasingly often. Presently, there exist many ready-made multidimensional scaling procedures in the form of computer software.[486]

Twentieth-century psychoacoustics, being a field concerned with the relationship between the objective, physical characteristics of sound and its subjective, impression-related qualities, introduced units for differentiating and describing such properties of the timbre as *acum* (sound sharpness – dependent on the loudness envelope of the spectrum), *asper* (roughness – dependent on temporal structure and amplitude modulation), or *vacil* (strength of fluctuation – dependent

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483 Marcin Strzelecki, *Witold Lutosławski – II Symfonia. Analiza z perspektywy psychoakustycznej [Witold Lutosławski – Second Symphony. Analysis from a Psychoacoustic Perspective]* [Master's thesis] (Kraków: Akademia Muzyczna w Krakowie, 2004), p. 60.

484 In this way, even sound qualities such as quality or meaning may be investigated, cf. Hugo Fastl, *Psycho-Acoustics and Sound Quality* [in:] *Communication Acoustics*, ed. Jens Blauert (Berlin-Heidelberg-New York: Springer Verlag, 2005), pp. 139–160.

485 See: Jan Żera, Tomasz Łętowski, *Skalowanie wielowymiarowe – możliwości i ograniczenia [Multidimensional Scaling – Possibilities and Limitations]* [in:] *Studia nad wysokością i barwą dźwięku...*, p. 205.

486 One may find an example of graphical representation of multidimensional timbre scaling [in:] Stephen McAdams et al., *Perceptual scaling of synthesized musical timbres: common dimensions, specificities, and latent subject classes*, *Psychological Research* (1995), Vol. 58, issue 3, p. 177–192, http://articles.ircam.fr/textes/McAdams95a/.

on amplitude changes).[487] Admittedly, one can hardly encounter these units in musical analysis at present, but they are sometimes used in virtual synthesizer interfaces. Here, it must be emphasised that acoustically-defined concepts are hardly ever present in the social evaluation of musical compositions. A knowledge of their meanings is more of a domain of the specialists, chiefly sound directors and acousticians.

The word 'timbre' itself (tone colour, German: *Klangfarbe*) is already a metaphorical and 'meta-sensory' term – after all, it is used colloquially for describing visual phenomena. Moreover, when describing timbre, visual-audial associations are sometimes employed to make a connection between the psychophysical characteristics of the sound source with the characteristics of its timbre. For some people, such associations may be more direct and based on chromesthesia, or hearing colour.[488] These auditory and timbral impressions make it possible to, among other things, combine the pitch (frequencies) or sound of different tonalities with colours. Further interactions between acoustic and visual colours may occur in audiovisual works. In film music, for example, certain sounds usually harmonise with the image, 'adding to' it emotionally, and thereby enhancing it. In contemporary audiovisual art, the relations between colours of images and sounds sometimes become the subject of intermedia play.

The hitherto-unattainable sonic phenomena enabled by electroacoustic music forced the search for new, appropriate terms.[489] As early as the 1960s, Pierre Schaeffer proposed his own, original typology of sounds encountered in electroacoustic music:

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487 Fastl, *Psycho-Acoustics and Sound Quality*…, pp. 139–161; Edward Ozimek, *Dźwięk i jego percepcja. Aspekty fizyczne i psychoakustyczne [The Sound and its Perception. Physical and Psychoacoustic Aspects]* (Warszawa—Poznań: PWN Scientific Publishers, 2002), pp. 271–272.

488 Chromesthesia is a kind of synesthesia, i.e. the onset of multisensory sensations when a stimulus acts on one sense.

489 Maciej Żołnowski believes that 'a sound described as soft, delicate, noble and vivid at the same time may be described using a single expression: "velvety" or "purple sound", and this is only because, as we all know, any fabric is soft and delicate to the touch, royal purple is an expensive and rare (and, by extension, noble) dye, and the colour purple belongs to the group of vivid colours'. To date, metaphorical terms this far-fetched have not found wider use in musical analysis or interpretation. See: Żołnowski, *Próba udowodnienia związku pomiędzy złożonymi skojarzeniami wizualnymi a semantycznym opisem barwy dźwięku na podstawie wybranych przykładów [An Attempt to Prove the Existence of a Relationship between Complex Visual Associations and Semantic Description of Sound Timbre on the Basis of Selected Examples (Master's thesis)]* (Wrocław: Akademia Muzyczna im. Karola Lipińskiego we Wrocławiu, 2001), p. 3.

— impulses and continuous sounds (*sons tenus*);
— sound blocks (*trames*);
— blocks of invariable volume (*facture nulle*);
— sounds excited multiple times (*sons iteratifs*);
— sounds with multiple dynamic shape changes (*facture imprevisible*);
— continuous sounds with unstructured variability (*echantillons*);
— structures made up of accumulated and superimposed small sound elements (*accumulations*);
— ostinato figures (*pedales*).[490]

These terms, although they have found wider usage, are universal and easily applied to the practice of musical interpretation. Essentially, they exhaust all possible musical events while directly describing the quality of tone and texture. Based on the work of Pierre Schaeffer, Denis Smalley in 1986 initiated a new research perspective dealing with the perception of traces of sound spectra over time, categorising sound objects – spectromorphology.[491] Smalley defined three basic morphological archetypes: short pulses, resounding pulses, and sonic bands.[492] Descriptive, spectromorphological sound analysis works well when it comes to electroacoustic music oriented towards shaping the sound, especially acousmatic music.

New media gave music the tools to make timbre a less elusive and more measurable musical quality. What could previously only be described subjectively, may now, owing to things like computers, be imaged, compared, and accurately measured in a variety of ways. The advent of new analytical tools – filters, oscilloscopes, spectrographs – meant that acousticians and composers were finally able to look 'deep inside' the sound, see it from the inside, and 'break it down'. This, in turn, spurred the beginning of a different approach to the creative process and, in consequence, the development of innovative compositional and pre-compositional techniques.

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490 Schaeffer, Reibel, *Solfège de l'objet sonore*…; also [in:] Kotoński, *Muzyka elektroniczna*…, p. 134.

491 Denis Smalley, *Spectro-morphology and Structuring Processes* [in:] *The Language of Electroacoustic Music*, ed. Simon Emmerson (London: Macmillan, 1986), pp. 61–93.

492 Denis Smalley, *Spectromorphology: Explaining Sound-Shapes*, *Organised Sound* (1997), Vol. 2, issue 2, pp. 107–126.

The classification of sensory data differs from the measurements that one may carry out using electroacoustic devices. Perceptual descriptions and classifications will always be doomed to carry a certain dose of relativism. Computer software permits multi-dimensional timbre scaling,[493] while also providing broad possibilities for visualising the acoustic signal, including in real time, which, quite literally, allows one to see the sound. The study of timbre and the factors that influence it plays a significant role when it comes to improving the design of musical instruments, sound systems, room acoustics, and many others. 'Supporting the theory of composition with analyses carried out in order to establish the physical properties of sound, as well as the study of the propagation of electromagnetic waves in different spaces and in relation to the physiological abilities of the recipient, constitute an important component of thinking of electronic and electroacoustic composition' – writes Roman Bromboszcz.[494] The rapid development of the analytical and synthetic capabilities of electroacoustic tools after World War II made the shaping of timbre a more important aspect of composition, but also changed the approach of artists using traditional instrumentation in favour of broader experimentation with them.

Notwithstanding the use of advanced analytical techniques in digital electroacoustics, such as real-time multidimensional spectrography, human speech recognition modules, or audio search engines, it has not yet been possible to develop tools for investigating the artistic and aesthetic values of sound. These remain within the domain of human interpretation.

2.2.2. Digitisation and virtualisation of sound – timbre and digital sound

The shift in from analogue to digital in sound recording and distribution has radically affected many important aspects of sound quality. It turned out that sound recorded and processed by digital means is

493 Such techniques, e.g. the KYST system, have been developed since 1964. See: Forrest W. Young, *Multidimensional Scaling*, http://forrest.psych.unc.edu/ teaching/p208a/mds/mds.html; Joseph Bernard Kruskal, *Nonmetric Multidimensional Scaling. A Numerical Method*, *Psychometrika*, 1964, Vol. 29, Issue 2, pp. 115–129, http://link.springer.com/article/10.1007%2FBF02289694?LI=true#page-1.

494 Bromboszcz, *Estetyka zakłóceń*…, p. 130.

distinguished by a particular kind of timbre; it can be much more faithful and clear, but also sharper (rougher) compared to 'smooth' analogue recordings.

An analogue signal is a direct representation of the temporal evolution of changes to the physical parameters of a sound wave, its pressure and acoustic velocity, through an electrical signal (specifically, voltage and current[495]); moreover, it is a continuous signal, i.e. one that is determined at every moment in time. Digitising a signal, on the other hand, involves quantising and sampling it, i.e. 'measuring' and storing a single value (amplitude), expressed numerically at specific time intervals,[496] whose range depends on the sampling frequency, or a certain kind of density of measurement points. This yields a discrete-time signal, i.e. one with values defined only at certain points along the time axis. This means that a certain kind of processing inaccuracy is allowed here each time, and it may be minimised by reducing the width of the quantisation intervals, but cannot be entirely eliminated. A sufficiently high sampling frequency – greater than the highest of the frequencies among the signal's harmonic components[497] – permits an optimal conversion of an analogue signal into a discrete, digital one from the perspective of human perception.[498]

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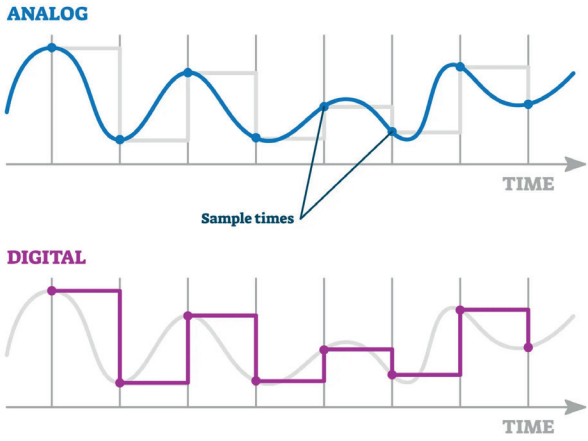
495 As early as the beginning of the 20th century, owing to Thomas Edison and Emil Berliner, it was discovered that any acoustic signal, no matter how complex, may be represented by a single curve. This fact was exploited in the creation of algorithms for sound synthesis.

496 Sampling, quantisation, and coding processes are usually carried out using an analogue-to-digital (A/D) converter. They entail representing the instantaneous value of a signal (sampling) at specific, usually equal, time intervals, determined by the sampling frequency. The instantaneous value of the signal is represented by a code word, whose values correspond to the selected intervals for the quantisation of the input signal. Assigning a range of analogue values to a single digital value always leads to a certain degree of inaccuracy (quantisation error). A higher sampling rate and a greater number of bits of the code word representing each sample yield a greater degree of accuracy of representation and faithfulness of the signal thus recorded to the original.

497 The sampling frequency should be twice as high as the highest frequency of the analogue signal to avoid information loss during processing. For an audio signal with a frequency of 20 kHz, the sampling frequency should be at least 40 kHz. By default, audio in compact disc format has a sampling rate of 44.1 kHz at 16-bit resolution per sample, and covers the entire frequency band range audible to humans and almost the entire dynamic range of audible sounds.

498 Owing to the digitisation of all music media, the ability to produce recordings of decent quality is now within the reach of anyone having access to microphones and a computer with the opportune software and sound card.

An analogue signal, however, is a waveform whose observation may serve for determining its characteristics; a digital signal is a sequence of digits in binary code.



Example 25. A graphical representation of the analogue signal (above) and the corresponding digital signal (below)

2.2.3. Sound architecture – around synthetic sound qualities

Electronic instruments are able to produce sounds (timbres and effects) by employing two methods: s a m p l i n g, i.e. the extraction and processing of pre-recorded musical or non-musical sounds (samples[499]), and s y n t h e s i s – the artificial generation of sound from scratch. A device for generating sounds is known as a 'synthesizer' or 'sound module', and the synthesising procedure itself is called an algorithm, within which the spectral amplitude characteristics, as well as the way the phonic signal is shaped, are defined based on a set of parameters. Owing to this, synthetic timbres are able to mimic the sounds of instruments or create new, previously unattainable sounds and simulate instruments that do not exist in the real world.

Sound synthesis may be based on analogue (hardware), digital (software) or hybrid technologies. Most methods of synthesis were developed before the digital revolution, although presently their digital versions are almost exclusively in use. Thus, the following types of sound can be distinguished according to the source:

499 A sound sample is typically a digitised sound, recorded digitally, usually with no compression (PCM format). The main parameters of the samples are the sampling rate and the bit resolution (number of bits per sample).

— acoustic;
— modified acoustic, electroacoustic (analogue and/or digital);
— electronic (generated and shaped by analogue and/or digital means).

This raises the question: can a modified timbre already be called synthetic? After all, it does occur that far-reaching processing make it impossible to identify and recognise its acoustic source.

The simplest and least invasive method of altering the sound, or, more precisely its volume, is electroacoustic a m p l i f i c a t i o n. As it has turned out, this opens up completely new possibilities for many instruments – for instance, the guitar, which was normally counted among the very quiet instruments, is now predominantly used as an electrophone – that is, in the form of an amplified electric guitar. The same happened with singing.[500]

Electroacoustic tools enabled the modification of the timbre of traditional instruments through the use of a variety of *effect processors* as part of the production of recordings, during their processing and while playing them live. The most popular sound modifying and enhancing effects include:

— delay lines – offering echo effects or looping capabilities;
— reverberation (reverb) – simulating the reflection of the spreading sound waves, and thus, by extension, the size of the room;
— free waveform generators (LFOs, flanging) – modulating the input sound, producing fluctuating and oscillating timbres;

500 For hundreds of years, vocalists kept developing their skills and technique in order to attain a voice as powerful and sonorous as possible, able to rival the volume of a large orchestral ensemble. This, of course, had its limitations, impossible to exceed without amplifying the voice. Building a theatre for the performance of his monumental operas, Richard Wagner designated a special room for the orchestra in order to muffle the volume of its sound, so that the soloists could be better heard by the audience. Gustav Mahler, on the other hand, in his monumental symphonics, balanced the volume of voices and instruments with a choir of several hundred. Ever since microphones and amplifiers had become popularised, singers have been able to develop their singing techniques in a different direction, so that the field of jazz and pop music, and, more recently, classical music employing electroacoustics, have been witnessing a shift away from the 'operatic' singing style and technique in favour of the new exploration of the timbral and expressive possibilities of the human voice. Owing to amplification, the timbre became much more important than its strength.

— chorus effect – extending and multiplying sounds, achieved by superimposing a slightly modulated and delayed signal over the original one;
— phase modulators (phaser);
— spectrum shifters (detuner, pitch shifter) – interfering with the spectrum of a signal, either by de-tuning or changing the frequency of the signal (e.g. pitch);
— distortion, overdrive, fuzz – obtained by exceeding the amplitude (voltage) of the signal, which excites additional harmonics, an effect making the sound 'dirtier';
— feedback.

A separate group is made up of different types of filters:

— low, high and band-pass filters, allowing selected frequency bands to pass (or low-, high- and band-stop filters);
— comb filters, 'sifting' the spectrum and possibly radically altering the sound; used to produce sharp, distinctive timbres;
— equalizers, changing the dynamic ratio between the registers, i.e. spectrum bands.[501]

The first attempts at electroacoustic signal processing were made early in the 20th century. When it comes to art, it was first employed by a German film director, Walter Ruttmann, in his pioneering acoustic landscape, *Wochenende* (1930).[502] The piece, commissioned by a Berlin-based radio station, is a collage of words, music and other sounds illustrating the end of a week in Berlin. 'Everything that is audible is also material,'[503] wrote Ruttmann in his 1929 manifesto, paving the way for the later musical avant-garde led by Pierre Schaeffer, Edgard Varèse and John Cage.

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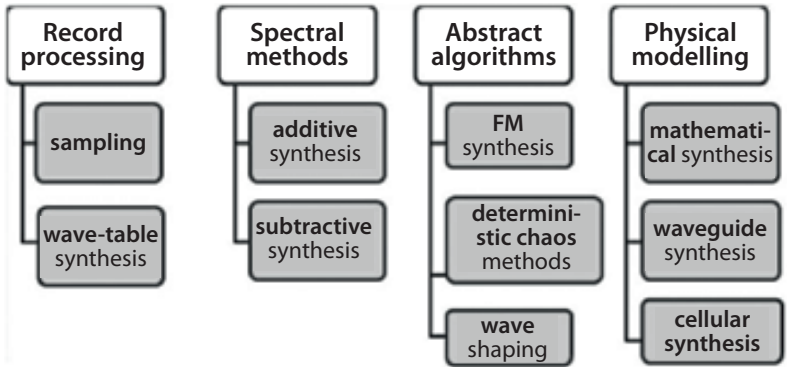
501 See: Stanisław Dinter, *Elektroniczne modyfikatory dźwięku [Electronic Sound Modifiers]* (Warszawa: Wydawnictwa Szkolne i Pedagogiczne, 1993).

502 Dariusz Mazurowski, *Walter Ruttmann i jego Weekend – zapomniany rozdział nowej muzyki [Walter Ruttmann and his Weekend – A Forgotten Chapter in New Music]*, *Estrada i Studio*, 2004, issue 9.

503 'Alles Hörbare der Welt wird Materia' – Walter Ruttmann, *Neue Gestaltung von Tonfilm und Funk. Programm einer photographischen Hörkunst*, *Film-Kurier* (1929), issue 255, p. 1 (reprint: Jeanpaul Goergen, *Walter Ruttmanns Tonmontagen als Ars Acustica*, Siegen: Universität-Gesamthochschule--Siegen, 1994, p. 25).



Example 26. The most popular sound synthesis methods

Quickly enough, sound s a m p l i n g began to be used in popular music (The Beatles, Frank Zappa, Pink Floyd), then dominated the music by DJs, as well as reggae, and, later, hip-hop in the 1970s. In compositional works, modifying the timbre of instruments using electroacoustic media ranges from simple procedures, such as the addition of an echo effect, to complex processing algorithms. At first, creators would modify recordings captured on film, soft gramophone discs or magnetic tape. One may find examples of this in the works of Darius Milhaud, John Cage and, in the late 1940s, Pierre Schaeffer and Pierre Henry, in their pioneering realisations of *musique concrète*.

It was not until the 1970s that the first commercial recorders and recording modifiers based on digital technology appeared (including the Computer Music Melodian monophonic digital sampler from 1976). Digital technology ushered in significant changes in the way sampling was carried out, radically streamlining and facilitating the process. Digital editing allowed free, selective copying and transfer of any part of the recordings, while analogue editing required cutting the tape mechanically and joining the fragments together using special plywood. Sound, in the form of a binary code, is easy to generate, transmit, store, and process using circuits and algorithms carrying out logical and arithmetic operations.[504] In the age of microprocessor-based electronics, the efficiency of and potential for manipulation have been further enhanced by graphical interfaces.

504 Jan Erhard, *Technika cyfrowa – podstawy. Zacznijmy od początku [Digital Technology – the Fundamentals. Let's Start from the Beginning]*, *Livesound*, 18/11/2010, http://livesound.pl/tutoriale/kursy/3938-technika-cyfrowa-podstawy-zacznijmy-od-pocztku.

Sampling techniques are focused on sound extraction and processing. The *sampler* is a tape recorder of sorts, able to record or input external sound samples into the device's memory, and then play the stored sounds back, offering the possibility to modify them. This processing may include transposition, deceleration, filtering, overlaying samples from different sources, and many other operations. Sometimes, the task of the sampler is to copy the sounds of acoustic instruments in a particular, unrealistic way, e.g. by looping, creating polyphonic versions of inherently monophonic instruments, creating sonic hybrids, etc. A sampler may also be 'multiple instruments in one', acting as a virtual orchestra. With the right quality of orchestral samples, composers are able hear their own works before they are performed live. Furthermore, the film industry has been making use of sampled music instead of large-scale orchestral recordings – which are very expensive – for many years. The quality of the sound samples and the capabilities of modern computers allow one to obtain satisfactory results in this regard – even professionals may have problems distinguishing recordings thus crafted from the sounds of acoustic instruments.

The first method for electroacoustic sound generation used in analogue synthesizers was s u b t r a c t i v e synthesis. It involves subtracting the input signals from one another. Subtraction is technologically similar to sampling, but the source material usually does not come from a recording, but from a waveform generated by an oscillator or a sound with a relatively rich spectrum, even noise, which is subjected to various types of filtering. Such a sound waveform sample, or, more precisely, its individual characteristics – shape, frequency, and pulse wave fill factor – may be processed using modification modules. Subtractive synthesis and sampling were initially carried out using voltage-controlled analogue modules. Today, Digital Signal Processing (DSP) or – in the case of software – algorithms are used, and the instruments in which they are applied are classified among virtual analogue synthesizers.

Another one among the oldest methods for generating sound is a d d i t i v e synthesis.[505] Unlike subtraction, it involves building a sound from scratch, i.e. superimposing individual (usually sinusoidal) waveforms, of which each may be modulated in amplitude

505 Roads, *The Computer Music Tutorial*…, p. 134.

and phase.[506] This method is easier to practise using software than doing it the original way, using hardware – the enormous mathematical complexity of the waveforms obtained (with the numbers of waveforms superimposed sometimes reaching the hundreds) requires the power of a computer.

When it comes to timbre, the possibilities in additive synthesis are endless. The use of generators enables one to obtain any frequencies both for the fundamental and for the constituent tones, which do not have to be a series of harmonic tones, but may be arranged in polytones composed in various ways.[507] Thus, addition made it possible to precisely build up artificial harmonic and non-harmonic spectra, to treat aliquots melodically, to compress and dilute the spectrum, and to overlay and smoothly transition between different spectra, i.e. to carry out sonic morphing. The spectral structures of synthetically-generated sounds may fulfil specific theoretical assumptions; they may, for example, reflect any mathematical model. This idea had already been used by Karlheinz Stockhausen in his *Studie I*,[508] *Studie II*, and *Gesang der Jünglinge*; the composer was able to produce sounds that were not only structured serially, but also based on a harmonic tone structure that was different from that found in natural sounds.

With most of the popular analogue synthesizers, sound generation was carried out by way of modifying, adding or subtracting basic acoustic waveforms: generally sine, rectangular, sawtooth and/

506 The first analogue synthesizers based on additive synthesis were built of an assembly of dozens or even hundreds of generators, along with modulators, amplitude and phase amplifiers, and an adder. This entailed not only high costs, but also the considerable size of the equipment. Another problem associated with this kind of synthesis was the jittering of the generators while using polyphony.

507 Eimert, for example, used sub-harmonic series in his *Glockenspiel*, and Stockhausen, in his *Studie II*, employed systems of component tones according to a scale constructed by dividing the interval of two octaves and a major third into 25 equal parts. At that time, Eimert wrote: 'the basic unit of electronic music is not the micro-interval, but something that lies in an entirely different dimension. It does not appear as the result of a division, instead constituting a kind of derivation of musical sound. Produced by the generator as an aliquot-free tone, having the form of a sinusoidal oscillation – the pure tone has long been known in acoustics, but is something entirely new in music. An equally new phenomenon are structural arrangements of sinusoidal tones, whose combinations of which make up sounds. For the first time, the intrasound structure is able to become an integral part of the overall structure of a piece'. Herbert Eimert, *Zur musikalischen Situation*, Köln 1954, quoted in: Kotoński, *Muzyka elektroniczna*…, p. 26.

508 *Studie I* is based solely on the additive synthesis of sinusoidal pure tones; cf. Holmes, *Electronic and Experimental Music*..., p. 136.

or triangular. Each of these waveforms is characterised by a different timbre: sawtooth-type sounds, for instance, are sharp, penetrating and unnatural-sounding, while sine wave sounds are soft, warm and gentle. These waveforms may be summed, multiplied, superimposed, or employed for controlling other signals.

In the late 1960s, John Chowning, a composer working at Stanford University, synthesised sounds using the well-known f r e q u e n c y m o d u l a t i o n process (or FM, for short), widely used in radio-communication. Chowning had noted that the decisive factor when it came to determining timbre was the nature of the temporal variations in the spectral components, which could be controlled using analogue oscillators.[509] The FM synthesis algorithm was patented in 1975[510] and, not long after, licensed to Yamaha, which then began manufacturing synthesizers based on the said method. Many of these have found their way into the hands of musicians and composers dabbling in electroacoustic art. In our day, these instruments are considered to have been ground-breaking and 'iconic'.

FM synthesis has proven to be markedly easier and more efficient to implement digitally. It was used in this form in the new generation of digital synthesizers, achieving commercial success with the now legendary Yamaha DX-7 synthesizer. Following the expiry of the Stanford University patent in 1995, FM synthesis found its way into most modern synthesizers.[511]

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509 Although this process in no way reflects either the physical properties of the instrument or the processes involved in the formation of an acoustic wave, it does produce results that are satisfactory for certain sound categories. John Chowning, *The Synthesis of Complex Audio Spectra by Means of Frequency Modulation*, *Journal of the Audio Engineering Society*, (1973), Vol. 21, issue 7, p. 21.

510 Even in the 1970s, the FM method was still being modified and refined. Contributions to the experiments were made by the Polish composer, Stanisław Krupowicz, who was Chowning's assistant at the time. The method's twin sister is synthesis by way amplitude modulation (AM), which involves multiplying two signals by each other, thus yielding frequencies being the sum and difference of the input frequencies (especially useful for creating metallic sounds).

511 One disadvantage of the method is that it produces a signal with harmonic components and a spectrum that is symmetrical – one might say, too perfect, while most natural sounds have an asymmetrical spectrum containing non-harmonic components. The spectra obtained by way of FM synthesis are unlimited, which, if the operations are performed in the digital domain, poses the risk of interference, known as acoustic aliasing.

A particular type of subtractive synthesis – and a convenient alternative to sampling and FM synthesis – was the wave-table method, also known as the table method, developed in the late 1970s by Wolfgang Palm. Here, the sound source is a memory ('table') containing short digital signal samples, which may be single wave periods or full samples of particular musical instruments (in which case it is also called PCM sampling synthesis).[512] Thus, the method uses a set of staggered wave tables, each of which describes a momentary signal spectrum. These are processed into a sound of opportune pitch and duration.

Waveshaping belongs to the abstract algorithm group. It is based on non-linear signal shaping, owing to which it has found application in generating sounds with an unchanging tone. It is very efficient and not particularly demanding computation-wise, but it does not offer one the possibility to directly synthesise non-harmonic and sub-harmonic components, which are an important part of the spectrum of natural sounds. It is not possible to synthesise transients, either, which precludes imitating the sounds of certain groups of instruments, especially wind instruments.

As a result of numerous experiments carried out as part of synthesis method refinement, it has been shown that algorithms of deterministic chaos, present in phenomena such as wind noise and therefore also airflow in wind instruments, are well suited for simulating the sounds of natural instruments.[513] One of the simplest examples of such a system is the Chua generator, which generates a wide range of stochastic or periodic waveforms, depending on one's choice of the individual element values.[514]

Physical modelling is the materialisation of the concept of synthesis based not on the spectral properties of the signal, but rather on the properties of the sound source and the physical processes occurring within it. With this method, the instrument – namely its acoustic parameters, rather than the sound produced by it – is 'simulated'. This allows one to create virtual instruments that would be

512 The name 'wave-table synthesis' may also refer to a subtractive method executed by digital means or using hybrid circuits (digital generators).

513 Chaotic generators also yield good results when synthesising string instrument sounds, but they require relatively high computing power.

514 In the Chua system, it is easy to control the signal and the signal envelope, notwithstanding the fact that the relationship between the control parameters and the sound characteristics is very complex – it is virtually impossible to obtain preconceived spectra. The sounds thus generated vary in time and fluctuate chaotically. See: http://holdenc.altervista.org/chua/.

difficult or even impossible to make in the real world[515]. Due to the way the physical model is constructed, three methods are distinguished here: mathematical, waveguide and cellular.

The mathematical modelling method is based on a wave equation describing the formation of sound in an instrument, such as the vibration of a string. Thus, the sound here is represented by a mathematical formula – a function that solves the equation defines the time-domain waveform of the resulting synthetic sound. This synthesis has become part of the field of research into the relationship between sound effects and instrument design. It is suitable for laboratory testing, which do not require calculations to be performed in real time.

Waveguide synthesis was developed in the early 1990s by Julius Smith of Stanford University, who noted that, for describing an oscillating system correctly, it sufficed to know the propagation parameters of the waves that made up the summed standing wave of an instrument.[516] This method proved to be efficient in practice, as it yielded good sound effects with low computational complexity, also permitting real-time applications. It has the advantage of being able to simulate the sound of real instruments and, more importantly, to take into consideration the articulatory phenomena and various structural aspects of the sound source.[517]

In the lesser-known cellular sound synthesis, the vibrating object being the source of sound is modelled in the form of elementary mass particles, or 'cells'. Each cell is linked to its neighbouring cell by elastic bonds. Making one of the cells vibrate induces in the medium a wave being the source of the synthetic sound. One key advantage of this method is the ability to model any shape, constructed using any material. Unfortunately, however, this requires the use of very powerful signal processors.

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515 It is possible, for example, to simulate a situation in which the body of a stringed instrument is excited by a double reed of a wind instrument.

516 The easiest way to explain the idea of this type of synthesis is to use the example of an infinitely long, perfect string whose oscillation can be described using a wave equation. Thus, what is created here is a model of a digital waveguide (acoustic wave channel), which is essentially a combination of delay lines and filters.

517 One disadvantage of the waveguide method, however, is the difficulty of formulating a physical model of the instrument (especially in the case of more complex processes).

One of the latest methods for generating sound is granular synthesis. Although its theoretical origins date back to the mid-twentieth century, it only began to be used on a wider scale in the 1990s for technical reasons. The first ones to consider sound as a collection of sonic micro-particles were Iannis Xenakis[518] and Dennis Gabor.[519] Based on his research around 1947, the latter formulated the thesis that sound is perceived as a series of short, discrete charges of energy. This theory posited that the human ear registers a single signal at a given frequency within a very brief time window lasting a little over ten milliseconds.[520] A single 'granule' may be considered as a quantum of sound energy, defined and controlled by time (volume envelope) or frequency (spectrum).

Xenakis began his theoretical research[521] into granular synthesis in 1958, but it was not until 1972 that his student Curtis Roads proceeded to its practical implementation using the then state-of-the-art computers.[522] In 1974, Roads created the first experimental granular piece, *Klang-1*, with a duration of 30 seconds. It consisted of just under eight hundred granules – about 25 played per second.[523] Subsequent, longer works by Roads were *Prototype* (1975) and *Nscor*, which was played publicly at the 1980 International Computer Music Conference in New York, contributing to the popularisation of the new method.

In the digital domain, most of the methods of synthesis that were developed using analogue media have expanded their capabilities radically, increasing efficiency and effectiveness. What used to require a composer to spend several months in the studio may now be achieved in a matter of days using a home computer. Furthermore, in its early portion of its life, synthesizer music sounded artificial and mechanical. This was due to the fact that it was impossible to synthesise the richness of articulation and fluctuation of the sound,

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518 The Greek composer employed the idea of sonic granulation in many of his orchestral works, in which a series of short sounds would integrate into a single textural and timbral quality.

519 Dennis Gabor (1900–1979) – Hungarian physicist, inventor of holography (1947), Nobel Prize winner (1971).

520 The selfsame perceptual property of sound has allowed digital audio formats to represent sound in the form of a sequence of discrete samples.

521 See: Iannis Xenakis, *Formalized Music. Thought and Mathematics in Composition,* ed. Sharon Kanach (New York: Pendragon Press, 1992), pp. 242–254.

522 Notwithstanding the access to state-of-the-art equipment and technology at the time, a minute of music took days to compute.

523 See: Curtis Roads, *Microsound*, (Cambridge MIT Press, 2004).

its – in this case desirable – 'imperfections'. In the traditional setting, the performer stimulates the instrument in a different way each time, creating various murmurs and 'sounds', and the sound spectrum is dynamic. Many of the sonic nuances resulting from the unpredictability and plasticity of human performance could only possibly be applied in digital synthesis. Digital oscillators proved to be much more accurate when it came to tuning, as well as faster when it came to response. This increased the tone quality, perhaps most importantly, allowed one to carry out synthesis in real time. This, in turn, paved the way for a new, very vibrant genre of electroacoustic music: live electronics.

Sound may be synthesised live, during a concert, and timbre may be shaped in real time, for example through various interactions or gestures by the performer.[524] This opens a world of tremendous opportunities for the contemporary artist dabbling in the multimedia. The movements of the performer or audience, graphical interfaces and visual layer analysis, and even human voice analysis may all be used to control a variety of sound parameters.[525] When producing sounds synthesised in this manner, a computer equipped with virtual instruments-synthesizers in the form of computer software becomes a universal working tool.

All of the synthesis methods are now widespread and available, both in hardware and software form, and synthesis technologies – constituting new ways of producing and shaping sound – are an indispensable part of the *métier* of every electroacoustic music composer; they have become, in a certain sense, the equivalent of instrumentation and orchestration skills in symphonic music. The possibilities for imitating natural sounds are now so extensive that, when it comes to perception, even an experienced musician may find it difficult to distinguish between artificial and natural sounds.[526] And, even

524 Marcelo M. Wanderley, Philippe Depalle, *Gestural Control of Sound Synthesis*, *Proceedings of the IEEE*, 2004, Vol. 92, issue 4, pp. 632–644.

525 This kind of system has been described extensively by Dan Stowell, who praised its intuitive interface and wide range of voice control. See: Dan Stowell, *Making music through real-time voice timbre analysis: machine learning and timbral control* [Doctoral thesis], School of Electronic Engineering and Computer Science, Queen Mary University of London, 2010.

526 This simulation potential is exploited by exploring Romantic and classical music, and even early music that was not yet recorded. All one must do is write down the score of a piece of music using a sheet music editor, and a piece of computer software will play us a hitherto-unheard piece of music. In order to become better acquainted with previously unrecorded or unperformed works, Kraków-based musicologist Maciej Negrey, specialising

though the original aim of perfecting synthesis techniques was that of imitating instruments, in artistic composition, these aims are shifting into the area of experimentation and exploration of new sonic worlds. In the words of Włodzimierz Kotoński:

> Using natural sounds to create an acoustic model is an important step towards understanding the nature of sounds themselves. It gives one an idea of the degree of complexity, irregularity, etc. necessary to recognise a certain class of synthetic sounds as artistically equivalent to natural sounds that have been traditionally regarded as musical, or only potentially musical, and allows us to track the coherence and the lack thereof in certain sound classes and the structures built from them.[527]

The basic criterion for the musical suitability of a given method of synthesis is its sonic effect. It is up to the creator to decide which tools they need and which technologies they will use. The interpreting artist, in turn, should know which compositional techniques – synthesis methods, programmes, devices, etc. – the composer employed in the piece; they must be armed with a basic knowledge thereof, as they have become the basis of the electroacoustic creative toolkit.

2.2.4. The role of timbre in works by 20th and 21st century composers

— **Emancipation of timbre: impressionism – serialism – sonorism – spectralism**

The object of timbre experimentation for the last few centuries was the orchestra – a universal meta-instrument of sorts. As part of this experimentation, composers increasingly favoured textural and timbral modelling over motivic work and reasoning in terms of motifs and themes. The additional inclusion of electronic media has resulted in even greater changes to compositional poetics and aesthetics. A significant contribution to the 20th-century emancipation of timbre came from the musical impressionism of Claude Debussy

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in the study of Polish music of the 18th and 19th centuries, transcribes their scores into a score editor and then reconstructs them using synthetic timbres. Thus, he encourages the recording and publication of many valuable but forgotten works by Polish composers.

527 Kotoński, *Muzyka elektroniczna…*, p. 230.

and Maurice Ravel,[528] as well as from the technique of timbral contrasts and continuations (known as *Klangfarben*) of Anton Webern and Arnold Schönberg. The latter predicted that in the future it would be possible to replace the traditionally-construed melody in a piece with a melody of colours.[529] These ideas were fulfilled in the post-war serialism of the Darmstadt school (in Pierre Boulez's *Polyphon X* from 1951 and *Le marteau sans maître* from 1954, among others), annexing dodecaphonic serialism to non-pitch attributes of sound; also in early electronic music, which enabled the precise parameterisation of timbres. Such techniques were employed in both acoustic and electronic compositions by people like Karlheinz Stockhausen. In 1953, in his *Studie I* – a 'consistent serial composition' – he structured sonic timbres: owing to the electroacoustic apparatus, he was even able to serialise the degree of polytone saturation. In Poland, one of the first to adopt similar means was Konstanty Regamey, in *Hymn elektronowy [Electronic Hymn]* from the opera *Don Robot* (1959–1968).[530]

Timbre acquired a key form-shaping role, different from that in the case of serialism, at the dawn of the 1960s in Polish sonorism. This direction was developed and perfectly executed in works by Krzysztof Penderecki, Henryk Mikołaj Górecki, Witold Szalonek, Kazimierz Serocki, and many others. The case of Penderecki, in whose works a certain feedback loop occurs, is special: his encounter with electroacoustic media, which he explored at the beginning of his creative path in the Polish Radio studio, inspired him to experiment more boldly with the sounds of traditional instruments:

> What opened my ears was electronic music, created in the 1950s in experimental radio studios. It was something completely unimaginable – obtaining the kind of effects one can get using electronic machines. I have composed very few electroacoustic pieces,

528 See Małgorzata Furche-Jurczyk, *Brzmienie jako konstytutywny element dzieła muzycznego na przykładzie partii fortepianowych w wybranych utworach Maurice'a Ravela, Manuela de Falli, Béli Bartóka i Johna Cage'a [Tone as a Constitutive Element of a Musical Work on the Example of Piano Parts in Selected Works by Maurice Ravel, Manuel de Falla, Béla Bartók and John Cage]* (Bydgoszcz: Wydawnictwo Uniwersytetu Kazimierza Wielkiego, 2009).

529 Arnold Schoenberg, *Theory of Harmony*, translated into English by Roy E. Carter, (Berkeley, Los Angeles: University of California Press, 1978), p. 470.

530 In addition to the musical parameters, the space, the figures of the dancers, the colours of the light, and the text are serialised as well. See: Bogusław Schaeffer, *Klasycy dodekafonii [The Classics of Dodecaphony]*, Vol. 2, *Część analityczna [Analytical Part]* (Kraków: Polskie Wydawnictwo Muzyczne, 1964), pp. 330–336.

> though I have found this kind of music to be very inspiring. Without the electronic studio work, I would not have been able to write *Threnody, Fluorescences*, *Polymorphia*, or my string quartets.[531]

Similar inspirations may be found in works by many other prominent composers: György Ligeti, John Cage, and the previously-mentioned Stockhausen. Owing to the sonic possibilities offered by new media, the idea of musical sonorism is still present and boldly pursued by electroacoustic music makers.

A particular sensitivity to timbre has always been shown by French composers. That is why, in the 20th century and today, the Parisian centre for computer music – IRCAM – is the world's most important centre for sound research. Following in the footsteps of Giacinto Scelsi, the composers gathered around this centre found creative inspiration, in a certain sense, in the depths of sound. They discovered that sound had dimensions that were not limited merely to the external – time, pitch and loudness – but also had an 'inner life', which is to say depth, spectral space and spectral domain. In the 1970s, the fascination with this inspired a new, vibrant musical trend called spectralism,[532] which makes use of electronic media on many levels. Hugues Dufourt emphasises that 'electronics leads to a micro-analysis of the sound phenomenon that reveals its new structural orders and its unperceived field of possibilities'.[533] Jan Topolski also believes that, historically speaking, spectral music represents a synthesis of two great traditions:

> The emancipation and dominance of timbre and the close relationship between music and mathematics, the idea of art-science. (...) It is integrally linked to electroacoustic music and the achievements related to the analysis, synthesis and transformation of sound, as well as to sonoristic sound masses and extended instrumental techniques.[534]

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531 Anna S. Dębowska, *Penderecki: Inspiruje mnie Picasso [Penderecki: I am Inspired by Picasso]*, *Gazeta Wyborcza*, 2008, issue 269, p. 16.

532 Polish composers that were strongly influenced by spectralism included Dobromiła Jaskot and Paweł Heindrich.

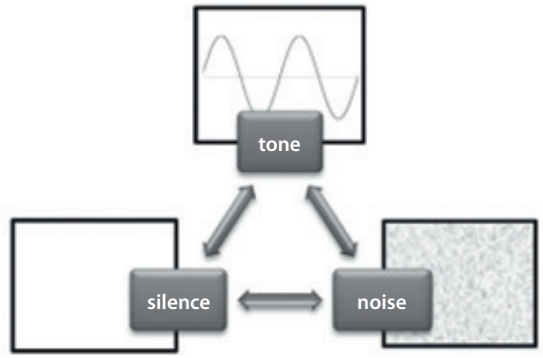
533 Dufourt, *Spectral Music* (1979), quoted in: Topolski, *Widma i czasy… [Spectres and Times...]*, p. 14.

534 Topolski, *Dlaczego Grisey? O muzyce twórcy spektralizmu w dziesiątą rocznicę jego śmierci mówią: Ewa Szczecińska, Paweł Mykietyn, Aleksandra Gryka, Jan Topolski and Wojciech Ziemowit Zych, [Why Grisey? On the Tenth Anniversary of his Death, the Music of the Founder of Spectralism discussed by: Ewa Szczecińska, Paweł Mykietyn, Aleksandra Gryka, Jan Topolski and Wojciech Ziemowit Zych], Ruch Muzyczny*, 2008, issue 26, http://www.ruchmuzyczny.pl/PelnyArtykul.php?Id=834.

Thus, in spectralism, timbre and harmony are fused into a single quality – 'timbre harmony'. Moreover, the spectral technique is better at integrating the electronic and instrumental parts, without being limited to 'a simple opposition or division between leading and accompanying roles',[535] Jan Topolski adds. Artists not directly associated with composition, but with acoustics and sound direction, played a key role in the emancipation of the new sound as well. It is to them that we owe the existence of…

— **The art of noise – noise as a new sound category**

Silence and noise are two sonic extremes. In between them, or, it should be said, next to them, one may place the simplest, 'ideal' quality – a single sinusoidal tone. All the sonic means of music fall between and within the framework of these three basic states:



Example 27. Extreme sound qualities

For centuries, anything and everything related to noise and other types of interference has been eliminated from music and its professional performance. Perfecting the technique of playing the instruments focused on eliminating all of the impure, imperfect sounds:

> As late as the 19th century, all sorts of noises and sounds not produced by musical instruments were radically separated from music, which was itself seen as the resultant of three overarching, constitutive elements: melody, harmony and rhythm.[536]

535 Topolski, *Czwarty wymiar dźwięku [The Fourth Dimension of Sound]*, *Odra*, 2004, issue 9, pp. 75–80.

536 Magdalena Figzał, *Muzyka teatralna i jej wymiar performatywny [Theatre Music and its Performative Dimension]* [in:] *Zwrot performatywny w estetyce…*, p. 184.

Although it was not until the middle of the 20th century that noise was allowed to join the club of full-fledged means of making music, the idea of composing music from noise was first conceived even before the First World War, by Luigi Russolo – one of the proponents of Futurism and musical bruitism. He constructed *intonarumori* – instruments generating a variety of sounds. The Italian composer wrote several works with his instrument-machines in mind, and considered the inclusion of noises and hums in the musical toolbox to be a 'logical consequence'[537] of the miraculous 20th-century innovations. In that age, the sounds of the city and machines became an intrinsic part of life, and, by extension, a new potential for inspiration in art. The Italian Futurist felt that, since the determining factor of modernity was the ubiquitous industrial noise, it stood to reason that it should become a building block of musical works as well. At that time, as a historical first, traditional instrumentation and broadly-accepted aesthetic norms were challenged. Paradoxically, the ideas of Russolo and other avant-garde Italian artists were executed better and in a far more radical manner by the Russian Futurists, e.g. by Arseniy Avraamov in his *Symphony of Factory Sirens*, for choir, cannons and all the sirens in the city (performed in 1922 in Baku and 1923 in Moscow). The noises made by various machines and devices – the civilizational symbols of the 20th century – entered the roster of innovative means of musical expression.

Important steps towards the acceptance of noises as fully-fledged musical sounds in 'high' art were taken by Edgard Varèse, who was the first to compose a piece for percussion instruments[538] and alarm sirens – *Ionisation* (1931). Importantly, he did not use sounds as a medium of musical illustration (as hitherto typical, if only in the context of using, for instance, a wind generating machine or gunshots), but rather as independent, non-mimetic sound qualities. The same idea accompanied Varèse when composing works already employing electroacoustic apparatuses, including the famous *Déserts*

537 Luigi Russolo, *The Art of Noises. Futurist Manifesto* (*L'Arte dei rumori*) (1913), http://www.arts.rpi.edu/public_html/century/MMC11/Russolo%20Art%20of%20Noises.pdf (access: 21 July 2014).

538 Any 'noise' percussion instrument was considered an imperfect one until at least the Baroque era. In ancient Greece, they were deemed 'non-divine', not originating from the Muses.

and *Poème électronique*.[539] The ideas initiated by Russolo and Varèse were continued and fully carried out by John Cage. He abolished the boundaries between instrumental sounds, noise, hums, and all kinds of other effects and noises completely. The expansion of the palette of sonic possibilities resulted in the abolition of the sonic hierarchy. Noises and hums have finally become sounds on equal footing with others, and, in avant-garde music, even privileged.

In colloquial speech, as is clear from the etymology itself, the words 'noise' and 'hum' refer to negative sound phenomena.[540] From an acoustic perspective, however, hum is uniform and continuous, with an equal distribution of energy in each frequency band, and its spectrum is well-balanced over most of the audible range. Noise is a sound quality of indeterminate pitch and murmur character, consisting of a large number of evenly distributed components with frequencies infinitely close to one another. Noise is neither tone nor rhythm, but it may, as a synthetically derived sound effect, become the equivalent of a cluster in instrumental music.

Torben Sangild believes that establishing a single, coherent definition of noise is not possible. This concept must be considered separately in several aspects: physics,[541] psychoacoustics, and communication.[542] A convincing and multifaceted theory of noise was presented by Roman Bromboszcz in his work *Estetyka zakłóceń [The Aesthetics of Interference]*, in which he proposes the following typology of musical noise:

— selection noise, tantamount to unpredictability in the structure of the composition, novelty, difficulty taking the piece in for the listener;

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539 'Timbres and their combination – or better, quality of tones and tonecompounds of different pitch, instead of being incidental, become part of the form, coloring and making discernible the different planes and soundmasses, and so creating the sensation of non-blending', Edgar Varèse, quoted in: Fernand Ouellette, *Edgard Varèse*, translated into English by Derek Coltman (New York: The Orion Press, 1968), p. 200.

540 The English word 'noise' is derived from the Greek *nausea*, used to describe the noise of a rough sea, but also seasickness; in Old French, *noise* meant a quarrel.

541 In acoustics, several types of noise are distinguished, depending on the frequency bands that they cover. The most important of these are white noise (full frequency range) and pink noise (with its frequency spectrum proportional to the inverse of the frequency, and its power density falling around 3 dB per octave, meaning that pink noise has equal intensity in each octave).

542 Sangild, *The Aesthetics of Noise*…, p. 4.

— structural noise, i.e. transformations of the sound wave leading to a change of the spectrum into a continuous one or to the loss (acquisition) of certain relevant qualities; in this case, one may distinguish instrumental, analogue, and computer noise;
— epistemic noise, caused by semantic instability, collagicity of statements, lifting of genre identity, etc.[543]

When considering the problem so broadly, one may notice that, semantics-wise, noise may have connotations other than those pertaining to acoustics. In communication theory, 'noise' is anything that interferes with the main signal between the sender and the receiver, or the result of a certain kind of information overload in the signal[544]. In colloquial speech, noise is disorganised – it is the opposite of structure, disinformation.

As younger, avant-garde artists dove headfirst into the vast ocean of possibilities offered by electronic media, a qualitative re-evaluation of sorts occurred, as the sounds that are now considered modern and appealing are, indeed, of a noisy, disruptive, musically 'crippled' nature. To the ear of a listener living a century ago, they would certainly have been unbearable gibberish. The new genres of electroacoustic music, such as noise and glitch,[545] which emerged at the end of the 1980s and are defined by timbres and sounds of noise, feedback, interference and other 'marginal sounds', can serve as an example here. While noise requires no use of electronics, glitch involves the use of digital sound processing tools, which become – this time, intentionally – a source of errors: jams, distortion, noise, overdrive, and clicks and cuts. Rather than being something undesirable, signal interference itself becomes a sound expressing the nature of the medium employed. The glitch trend, although it did not manage to attain significant popularity, was a manifesto of aesthetic revolution for electronic music – it made hitherto-disowned sounds desirable and meaningful. The glitch and noise currents are part of the trends present in various fields of art oriented towards the 'aesthetics of flaws'.[546]

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543 Bromboszcz, *Estetyka zakłóceń…*, p. 174.

544 Radosław Sirko, *Inny noise. Biały szum a czarny metal [Another Kind of Noise. White Noise versus Black Metal]*, *Glissando*, 2013, issue 22, http:// glissando.co.uk/text/other-noise-white-noise-a-black-metal/.

545 Cf. Chapter 1.3.

546 Moradi, *Glitch Aesthetics*…

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Electroacoustic music became an emanation of a new sonority, and gave artists the opportunity to search for and compose sounds that were 'dreamlike', 'impossible', and 'ideal'. Acoustic instruments continue to be the subject of new techniques of performance and articulation, but they will never provide timbre shaping possibilities so extensive as in the field of electroacoustics. Furthermore, the traditional notation method is not perfect enough to enable the composer to notate timbre nuances precisely. Notation is, after all, subject to interpretation by the performer and occurs under different acoustic conditions. Electroacoustics, meanwhile opened the opportunity to perform a work in the form of a permanent recording of the sonic results, without the participation of the performer. Such 'tape music', i.e. music played during a concert from a recording, had proponents and opponents alike, the latter pointing to the dehumanisation of art. This problem was solved in part by combining tape with acoustic instruments, as well as in the live electronics trend, where sonic transformations take place live during the performance.

Electroacoustics, combined with modern sound systems, has radically expanded the repertoire of sonic possibilities, also in terms of achievable frequencies – never before have sounds of such extremely low and high pitches been used in music. Even sounds inaccessible to human auditory perception, 'mute' sounds, i.e. infra- and ultrasounds, have become valuable to electroacoustics, and thus, by extension, to artists. As it turns out, these sounds have a profound effect on humans and their perception and physiology. Such music, when received through speakers or headphones, may exert a completely different effect on the listener than natural acoustic sounds.[547]

The structuralist element, so clearly dominant in 20th-century sound systems, has been in a crisis of sorts since the beginning of the 21st century, perhaps exhausting itself. Looking for new solutions, some artists turn to tradition and timeless ideas through, for instance, tonal and modal connotations, whereas others explore microtonal intervals and construct their own sound systems. For others still, it was the shaping of timbre that has become one of the primary means

547 Extremely low-pitched sounds may affect mood, have an analgesic effect, a sleep-inducing effect, help with concentration, learning, etc. This effect may be achieved using, among other things, differential beats (binaural beats) and isochronic tones – specially prepared, artificially generated sounds that influence the activity of the human brain. Ultrasounds are also employed in medicine.

of expression in music. In electroacoustics, this takes place in the most direct of ways, as working with digital sound synthesis in the studio is very different in nature to scoring composition. Orchestral proficiency, in which the creator's imagination played no small part, has been replaced by studio experimentation with timbre made 'on the fly', using interactive graphic interfaces and software. In the present day, this kind of sound shaping forms the basis of the production toolbox for electroacoustic music.

2.3. Space and spatiality in electroacoustic works

2.3.1. The architects of musical spaces

The advent of electronic media marked a new direction both when it came to shaping the sound space and the use of the effect of spatiality, although the ideas behind this were nothing new to music at all. Raymond Murray Schafer believes that they are the consequence of aspirations that have been mounting for several centuries. Introducing dynamics, echo effects, separating sound sources, separating the soloist from the ensemble – all of these as were seen by Schafer as attempts to create 'virtual spaces', larger or different from the natural acoustic space of the room.[548] This issue has been food for thought for composers almost since time immemorial. Even the ancient Greeks built monumental, acoustically resonant amphitheatres. During the Middle Ages and Renaissance, successive generations of composers were inspired by the majestic interiors of cathedrals and churches, creating hitherto-unattainable acoustic qualities, giving the sound of the human voice depth and power. Examples include the polychoral works by representatives of the Venetian (Adrian Willaert) and Roman schools (Giovanni Pierluigi da Palestrina), the later topophonic techniques of the *cori spezzati* of Andrea and Giovanni Gabrieli, Claudio Monteverdi, Alessandro Striggio (e.g. the multi-choir *Missa sopra Ecco sì beato giorno*) and Thomas Tallis (the 8-choir, 40-voice motet *Spem in alium*). One may also find the idea of dialogue within separate musical spaces in instrumental music in the Baroque *concerti grossi*; in classicism, in Mozart's operas; in Romanticism, in works by Hector Berlioz, who in the *Symphonie fantastique* has the oboist play offstage, and in *Requiem* places four separate wind instrument ensembles in the corners of the stage. At the dawn of the 20th century,

548 Schafer, *Muzyka środowiska,* translated by Danuta Gwizdalanka [in:] *Audio Culture*..., p. 58.

one may find the effects of acoustic remoteness, or even concealment, in Gustav Mahler's monumental symphonies. Many composers have recognised that the sound material of a work may be just as important as the location of the sound source and the way it spreads. In this way, taking into account and emphasising the role of space as a formative element in musical composition gradually shifted music away from the traditional paradigm of temporality.

The real revolution in the sphere of topophonic sound effects came in the 20th century. Spatialisation has, after all, become an important proxy for the technical development of recent music. One of the first composers to explore the new possibilities for creating musical space in the 20th century was Charles Ives. The American composer was interested both in the positioning of the choir and orchestra in relation to the audience and in the juxtaposition of different musical planes – textural spaces. A testament to this are the three-orchestra *Fourth Symphony* (1912–1918) and the unfinished *Universe Symphony* (1915–1928). Not long afterwards, the term 'spatial music' was first used by Edgard Varèse in relation to his *Intégrales* for wind instruments and percussion (1924–1925).

'In every century,' notes Bogusław Schaeffer, 'there are works created against the backdrop of spatial imagery (...). These were, however, examples of very simple concepts, not changing the music itself in any way. It was only in our half of the century [in the second half of the 20th century – A.M.] that the idea of a systematic treatment of the spatial parameter emerged'.[549] One of the principal reasons for the growing interest in musical spatiality was the rapid development of electroacoustics.

John Cage executed the idea of a spatial soundscape in a peculiar way, involving chance, in his cycle *Imaginary Landscapes* (1939–1952), one of the first musical works to make use of electronic media: cassette tapes and radios. In Cage's performative projects, on the other hand, the work enters the sphere of real space, the space of life, 'which is filled with its presence by the performers and the audience mingling with them. The work becomes a space of presence,'[550] diagnoses łukasz Guzek. Another American composer, Henry Dreyfuss Brant, inspired by the concept of Renaissance antiphonal music, took up the idea of acoustic spatial music and, starting with *Rural Antiphonies* (1953)

549 Schaeffer, *Mały informator muzyki XX wieku [A Small Guide to the Music of the 20th century]*, 3rd edition (Kraków: Polskie Wydawnictwo Muzyczne, 1975), p. 198.

550 Guzek, *Sztuka instalacji…*, p. 27.

carefully planned the placement of the musicians in the concert hall in more than a hundred of his chamber and orchestral scores. At the same time, Iannis Xenakis was composing *Terretektorh* (1956–1966), a work in which 88 performers are arranged around and among the audience, for the first time providing the opportunity to listen to the orchestra, in a certain sense, 'from the inside'.

Spatiality piqued a strong interest of one of the most prominent creators of the post-war avant-garde, Karlheinz Stockhausen, a large part of whose work was described by Bogusław Schaeffer as 'spatial structuralism'.[551] The German composer wrote spatial pieces both within the sphere of *elektronische Musik* and that of traditional instrumentation,[552] including *Gesang der Jünglinge* for five-channel tape (1956), the quadrophonic *Kontakte*[553] (1958–1960) and *Hymnen* (1967), *Gruppen* for three orchestras (1957), *Momente* for soprano, four choirs and thirteen instrumentalists arranged around an auditorium (1964), *Carré* for four orchestras and choirs (1960) and *Fresco* for four orchestras (1969) – a kind of six-hour 'sound wallpaper', performed simultaneously in four adjacent rooms.[554]

When it comes to Polish music, of note are the achievements of Kazimierz Serocki, who, at the turn of the 1950s, not only began to consciously model the spatial relationships between musical structures in his works, but also proposed his own concept for the spatial movement of sounds, resulting from the opportune disposition of instruments on stage. In his *Episodes* (1959), instruments are arranged in straight lines (rows of violas and double basses), in a 'v' shape (cellos), in a semi-circle (violins) and punctuated (percussion), and, one could say, convey successive 'sound shapes' to one another, creating an auditory effect of sounds shifting.[555] The scores for *Phantasmagoria* or *Pianophonie* also contain precise diagrams

551 Schaeffer, *Mały informator muzyki XX wieku…*, p. 198.

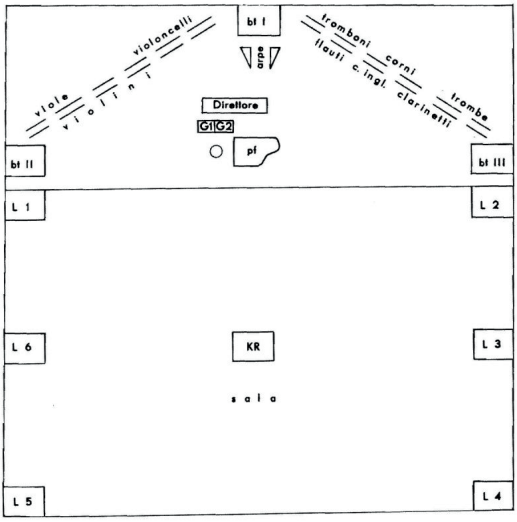
552 For works such as *Kreuzspiel* for oboe, bass clarinet, piano and four percussionists (1951) or *Zyklus* for one percussionist (1959), the composer gave suggestions for the spatial arrangement of the instruments and musicians, their gestures and movement on stage.

553 In *Kontakte*, Stockhausen achieved the effect of sound circulating – at different speeds – around the listeners. For the recordings, he used four regularly spaced microphones to record the sound emanating from a loudspeaker mounted on a rotating platform.

554 Stockhausen verbalised his concepts in lectures and theoretical essays, including, among others, in *Music in Space* from 1958. See: Stockhausen, *Texte 1* (Köln: DuMont Buchverlag, 1958), pp. 152–175.

555 Iwona Lindstedt, *Notacja i przestrzeń dźwiękowa [Notation and the Sound Space]* [in:] Lindstedt, *Serocki*, Polmic-ZKP, 2012, http://www.serocki.polmic.pl/.

and comments on the spatial disposition of the instruments used, ensuring that the composer is fully aware of how to shape both the stage and acoustic space. In the same period, similar techniques were employed by Henryk Mikołaj Górecki in his serial-sonorist *Scontri* for orchestra, followed by Krzysztof Penderecki, Witold Szalonek and many other prominent representatives of the Polish avant-garde.



Example 28. K. Serocki: *Pianophonie* – spatial arrangement of instruments and electronic apparatus in the concert hall

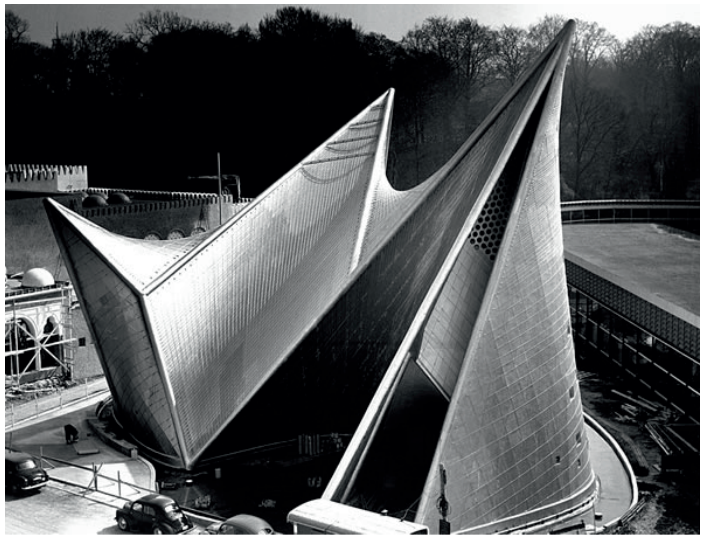
In instrumental theatre, a genre pioneered and championed in Poland by Bogusław Schaeffer, sound is made spatialised in a different manner altogether. Ewa Synowiec has described these works as 'audiovisual music'[556] for a reason: sounds, words, movements, and gestures constantly meet and cross one another, and the visual stage space corresponds with the musical space. A different kind of handling of spatiality – in this case relating primarily to the aspect of timbre – was employed by Schaeffer in his sonoristic *Topophonics* for 40 instruments (1960), where the mosaically sequenced motifs played by individual instruments form a kind of 'passacaglia of instrumental sounds'.[557]

556 Ewa Synowiec, *Teatr instrumentalny Bogusława Schäffera [Bogusław Schäffer's Instrumental Theatre]* (Gdańsk: Akademia Muzyczna w Gdańsku, 1983).

557 Jadwiga Hodor, commentary on the piece *Topophonics* [in:] *Warszawska Jesień '89. 32. Międzynarodowy Festiwal Muzyki Współczesnej, 15–24 września 1989 [Warsaw Autumn '89. 32nd International Festival of Contemporary Music, 15–24 September 1989]*, [programme book], p. 181.

One of the pioneers of electroacoustic 'spatial music' (in his own words) is Zygmunt Krauze, author of *Spatial-Musical Composition No. 1* for 6 tapes (1968) and *No. 2* for 2 tapes (1970), *Automatophone* for 15 playing mechanisms and 15 plucked instruments (1974), *Fête galante et pastorale* for 6 instrumental groups and 13 tapes (1974), and *La rivière souterraine* for clarinet, trombone, cello, piano, percussion, guitar, accordion and 7 tapes (1987). The presentation of his works typically takes place in a specially selected or designed architectural space. For Krauze, when it comes to creating artistic meaning and form, space and the musical content and are elements of equal importance. The presentation venue for *Spatial-Musical Composition No. 1* consists of several rooms; each room contains a source of music and light. The movement of the audience through this space defines the individual perception of the music and constitutes the entirety of the form,[558] close to the environments art.

A pioneering work when it came to the creation of architectural multimedia spaces was the futuristic Philips Pavilion designed by Le Corbusier – in collaboration with Iannis Xenakis and Edgard Varèse – and presented at the 1958 World Expo in Brussels.



Example 29. Philips Pavilion, EXPO'58, Brussels

558 See: Krauze, *Muzyka przestrzenna*, http://www.zygmuntkrauze.com/pl/muzykaprzestrzenna.html.

Inside, a gargantuan 11-channel sound system (made up 425 loudspeakers) was installed, allowing an effect in which sounds were able to move along and across the room, 'drawing' invisible lines of sound. This system and the special acoustic properties of the pavilion were used by composers for preparing electronic music. Pieces by Xenakis (*Concret PH*) and Varèse (*Poème électronique*), composed specially for the occasion, became part of an audiovisual performance set in the central part of the pavilion, combining film, lighting effects and music. To this day, *Poème* remains one of the most spectacular examples of spatial multimedia art and one of the most important works by the artist, 75 years old at the time. As one of the first composers associated with electroacoustics, Stockhausen, too, called for the construction of concert halls adapted to the requirements of the new, spatial music. One of his most interesting ideas was the 'acoustic sphere' – a large room with speakers installed around it, with a transparent platform for the audience suspended in the middle. Owing to this design, sounds were received from all sides, including from above and below. The idea was successfully executed at the 1970 World EXPO in Osaka.

Recently, electroacoustic music has increasingly been performed in unusual venues which are not institutionally associated with serious musical works.[559] These are usually huge, high-ceiling rooms with around a dozen seconds of reverberation and a futuristic atmosphere, meant to inspire artists to make opportune use of their unique acoustics – a way of presenting music that would reveal the acoustic qualities of the space in question that would otherwise be inaccessible.

2.3.2. Sound space versus acoustic space – terminological issues and typologies

The exact sciences define space as a kind of structure in which the various relationships and activities between its elements are defined. Space is something that permeates and surrounds everything; it is the site of all physical phenomena. However, while in centuries past the concept of space was generally used and explored from the

559 An example of such undertakings in Poland is the 'Warsaw Autumn' International Festival of Contemporary Music, whose concerts have already taken place in, for instance, the Highest Voltage Hall of the Power Engineering Institute, the EXPO Hall, Fabryka Trzciny, the former 'Koneser' Vodka Factory, and many other industrial interiors. In recent years, performing music in unusual spaces has become increasingly common. One example of this is the Wieliczka Salt Mine, where concerts of both classical and popular music have been held for many years.

perspective of physics, mathematics or philosophy, in the 20th century (whose latter half Michel Foucault called the 'epoch of space'[560]), and even more strongly in the twenty-first, it is confidently entering the humanities debate, too, including the context of art. For a number of centuries, the issue of space in music has been overshadowed by temporality – music has always been seen primarily as a sequence of sounds in time and treated as a typically temporal art form. And yet, time and space are inextricably linked – including in art.[561] The materialisation of sound relies on its temporal-spatial representation – music is only able exist and be perceived in the context of some kind of space. Space enhances sound, brings it to life, and is the integrating factor for all acoustic phenomena when it comes to music. The sound 'brings out the space'[562] and interacts with it in a certain kind of way. Bogusław Schaeffer, on the other hand, defines time as a 'resultant factor' between sound and space, but 'no longer conceived as the duration of the sound phenomenon itself, but as the equivalent of distance'.[563] If the perceived sounds were not to have spatial properties, they could not belong to the external world, and thus hearing could not be considered a perceptual modality.[564] However, proving that

560 Alicja Kuczyńska, *U źródeł ponowoczesnej fascynacji „epoką przestrzeni" [At the Roots of the Post-Modern Fascination with the 'Epoch of Space']* [in:] *Czas przestrzeni [The Time of Space]*, ed. Krystyna Wilkoszewska (Kraków: Universitas, 2008), p. 170.

561 Demonstrating that the inseparability of time and space is one of the most important laws determining the ways of artistic creation of the represented world and the human image placed therein, Mikhail Bakhtin introduced the concept of chronotope into literary studies. Cf. Anna Burzyńska, Michał Paweł Markowski, *Teorie literatury XX wieku. Podręcznik [Theories of Twentieth Century Literature. Handbook]* (Kraków: Znak, 2006), pp. 160, 164.

562 Robert Losiak, *Doświadczenie odbioru muzyki w świetle fenomenologii percepcji Maurice'a Merleau-Ponty'ego [The Experience of Music Reception in the Light of Maurice Merleau-Ponty's Phenomenology of Perception]*, *Muzyka*, 2005, issue 1, p. 97.

563 Schaeffer, *Mały informator muzyki…*, p. 198.

564 Andrzej Klawiter, Anna Preis, *Percepcja słuchowa przedmiotów. Szkic teorii i jej testowanie [Auditory Perception of Objects. A Sketch of the Theory and its Testing]*, *Kolokwia Psychologiczne. Pismo Komitetu Nauk Psychologicznych PAN,* 2006, Vol. 14, p. 146.

music itself possesses any extra-temporal space is difficult; rather, it creates an illusion thereof.[565] Music may therefore have attributes of space, but it is only an imagined, implicit, virtual one.[566]

The new media's potential for shaping and creating space has led to increasing attention being paid to its role. Electroacoustics has, in a certain sense, sensitised composers and listeners alike to the hitherto-neglected or overlooked attributes of sound. The issue of space has even become one of the most important aspects of creation, performance, and reception alike. Taking this issue into consideration seems to be essential in the interpretation of electroacoustic music, too, and certainly more important than in cases where traditional instrumentation is used. In music for acoustic instruments, the spatiality of sounds only comes into being during performance; electroacoustic works have a space of their own, created by the composer.

The concept of space is sometimes used in music to refer to at least a handful of aspects. It is usually used to metaphorise the time span, form, and sometimes texture of a piece. In music theory, musical space is, therefore, associated with

the sound material (*soundspace*, pitch space) and defines it as a collection of time-, pitch- and volume-differentiated sounds or 'the overall result of construction processes'.[567] The term is, therefore, used in the context of pitch ordering and sound ambitus. This understanding of musical space dominated the theoretical considerations until the first half of the 20th century, when the concept became a heavily-debated issue in German musicology. Even Hermann von Helmholtz closely linked musical space to scales and the temporal succession of sounds.[568] Hans Mersmann, on the other hand, distinguished between two dimensions in space: horizontal (corresponding

565 According to Susanne Langer, musical space may only constitute a secondary illusion, the primary one being the illusion of time; Cf. Susanne K. Langer, *The Primary Illusions and the Great Orders of Art*, *The Hudson Review*, 1950, Vol. 3, issue 2, pp. 219–233, http:// www.anthonyflood.com/langerprimaryillusions.htm and: Mary J. Reichling, *Susanne Langer's Concept of Secondary Illusion in Music and Art*, *Journal of Aesthetic Education* (1995), Vol. 29, issue 4, p. 39, http://connection.ebscohost.com/c/articles/26049298/susanne-langers-concept-secondary-illusion-music-art.

566 Carmen Chelaru, *The Music Space* [in:] *Recent Advances in Acoustics & Music* (Iasi: Enescu University, 2010), p. 83, http://www.wseas.us/books/2010/Iasi/AMTA.pdf.

567 Bohdan Pociej, *O przestrzenności dzieła muzycznego [On the Spatiality of a Musical Work]*, *Muzyka* (1967), issue 1, p. 69.

568 von Helmholtz, *On the Sensations of Tone…*, p. 370.

to melody) and vertical (corresponding to harmonics).[569] It was only Ernst Kurth who posited that the sensation of space manifested through movement was an internal, autonomous psychic experience ('inner listening'[570]) and not a feature of the sounds themselves.

Albert Wellek was the first to make a distinction between auditory space (*Gehörraum*) and sound space (*Tonraum*), both making up the overall auditory effect.[571] In his writings, he argued that space is of a cognitive, not phenomenal nature. Just as for Kurth and Wellek, for Roman Ingarden musical space was related neither to the actual venue of the performance nor to the imaginary form, but rather to the multifaceted movement of musical structures whose shapes lay in the composer's intent. Indeed, basic musical structures, such as melody and rhythm – although they develop and 'move' over time – may be perceived as a shape, a figure, or a musical gesture.

It has been rare to consider the issue of spatiality in relation to the performance environment. This aspect is more closely related to other, more recent concepts: *acoustic* space (referring to acoustic, physical phenomena, sound propagation, and ambient effects), the visible stage space – or *performative* space, and *psychoacoustic* space – or *auditory* space (referring to, among other things, to the perception and location of the sound source). Edward A. Lippman was one of the first to consider the problem of the 'external', performative musical space in philosophy. Based on numerous psychoacoustic studies, he emphasised the multifaceted nature of the perception of music, and made a firm distinction between the empirical, sensory auditory space and the inner sound space (which, on that note, he himself redefined after reading works by Kurth, Wellek, and Gisèle Brelet[572]).

Acoustics is a broad field, encompassing not merely the study of the nature of sounds themselves (for this field, sound is but a disturbance in air pressure, a wave spreading in space), but also the way they interact with their environment. Psychoacoustics, on the other

569 Hans Mersmann, *Angewandte Musikästhetik*, (Berlin: Max Hesse Verlag, 1926), cf. Maria Anna Harley, *Space and Spatialization in Contemporary Music*: *History and Analysis, Ideas and Implementations* [Doctoral thesis] (Montreal: McGill University, 1994), p. 58, http://www.moonrisepress.com/dissertation.html.

570 Ernst Kurth, *Musikpsychologie* (Berlin, 1931), pp. 134–136, http://vlp.mpiwg-berlin.mpg.de/pdf/lit39506_Lo.pdf (access: 21 July 2014).

571 Albert Wellek, *Musikpsychologie und Musikästhetik* (Frankfurt am Main: Akademische Verlagsgesellschaft, 1963), pp. 208 and 307.

572 Edward A. Lippman, *The Philosophy & Aesthetics of Music* (Lincoln et al.: University of Nebraska Press, 1999), pp. 26–40.

hand, investigates not the acoustic and musical space, but rather the impression of spatiality. It is these aspects – musical spatiality and spatialisation – that seem to be more important to electroacoustics than musical or sonic space. Erik Davis, one of the most eminent researchers of the issue of acoustic space in the context of technology and new media, emphasises that its attributes are simultaneity (i.e. the ability to perceive various spatial characteristics at the same time, organising an integral, coherent whole out of a variety of events), 'superimposition' (superposition, i.e. the overlapping of waves coming out of different sources), non-linearity, and resonance (interaction with the environment, transmission of vibrational energy).[573] Thus, the author emphasises the integrative role of space.

The term 'musical space' is sometimes even used in the context of timbre and the spectrum of sound (*spectral* space[574]), but, in such situations, its meaning is rather metaphorical.[575] In recent decades, terms such as sonosphere, phonosphere or audiosphere have also gained vogue. The presence of the '-sphere' suffix implies a connection to sphericity, as sound is something that surrounds things and spreads out around them. The term *sonosphere* refers to sound qualities and their origin, whereas *phonosphere* refers to the sounds of the human voice, as well as to the recording of sound (phonography). *Audiosphere* is the broadest of the three terms, denoting the sonic whole, all the 'sounds and noises that constitute the specificity of a given space'.[576]

A bigger problem appears when non-musical media come into play, i.e. when one deals with multi-sensory messages. In such cases, new concepts, even more difficult to grasp, enter the discourse of, for example, *audiovisual and multimedial space* or *intermedial*

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573 See: Erik Davis, *Techgnosis: Mit, magia + mistycyzm w wieku informacji [TechGnosis: Myth, Magic, and Mysticism in the Age of Information]*, translated by Jerzy Kierul, Rebis, Poznań 2002.

574 Peiman Khosravi, *Exploring the Boundaries of Spectral Space and Tonal Pitch Space* [in:] *Electroacoustic Music Studies'08*, http://www.ems-network.org/ems08/papers/khosravi.pdf.

575 It is most commonly used to refer to spectralism. One of its leading exponents, Gérard Grisey spread the spectral space of a single sound over the entire orchestra in his work *Partiels* (1975).

576 Tomasz Misiak, *Estetyczne konteksty audiosfery [The Aesthetic Contexts of the Audiosphere]* (Poznań: Wydawnictwo Naukowe Wyższej Szkoły Nauk Humanistycznych i Dziennikarstwa, 2009): p. 38.

space – understood as an area of dependence, synergy, and interaction between individual media. New forms of sound arts offer these different, newly shaped spaces the chance to complement one another.

Given the multitude of concepts and problems that arise around the issue of musical space, there have been numerous attempts to distinguish and organise them. Leszek Polony was able to convincingly put the ambiguity of this concept into a broader musicological perspective by distinguishing the following kinds of space:

— acoustic – physical, measurable, parameterisable;
— auditory – perceptual, 'given in sensory experience', in the 'act of listening';
— musical – organised by 'musical systems', simultaneously the inner space of the work (so this includes the sound space);
— symbolic – a space of 'imagined representations and associations', 'ideas, motifs and literary themes', e.g. river, mountain, sea, hike, etc.[577]

Though firmly rooted in traditional music theory, this distinction seems to be accurate and universal. However, when it comes to the field of electroacoustics, this division would require the inclusion of new terms and aspects. An attempt at creating such a typology was made by Maciej Żołnowski,[578] who distinguishes space according to the manner in which music and sound are created:

— *natural*, created by acoustic instruments; within it, space may be further distinguished according to the possibility of auditory illusions occurring:
    - real, that is, related to everyday life; without auditory illusions that would fundamentally falsify the image of the acoustic reality,
    - illusory, that is, blurring the image between reality and the illusory nature of sound phenomena, creating unnatural effects by natural means – close to musical sonorism,

577 Leszek Polony, *Przestrzeń i muzyka [Space and Music]* (Kraków: Wydawnictwo Akademii Muzycznej w Krakowie, 2007), pp. 9–10.

578 Division based on: Żołnowski, *Psychoakustyka: przestrzeń wirtualna w muzyce [Psychoacoustics: Virtual Space in Music]*, *Estrada i Studio*, 2003, issue 11, http://www.eis.com.pl/virtual/modules.php?name=Sections&sop=viewarticle&artid=665.

— *artificial*, which originates from electroacoustic media; according to the possibility of the phenomenon of imitation and illusion of real space occurring, it is further divided into:

  - mimetic ('imitative') space, called 'real' space, which attempts to imitate real spatial phenomena and real acoustic space,
  - virtual, unreal space not existing independently in our space-time world; a 'place' in which one cannot exist physically; an acoustic-musical cyberspace,

— *hybrid* space – a combination of both (This allows a work of art to become the meeting point of two spaces – the real and the virtual[579]).

While Żołnowski focused not so much on space as on sound as a phenomenon in itself, on its sonic qualities, and its source (if one were to replace the word 'space' with 'sound', the distinction would remain just as opportune), the typology and terms used herein may prove useful for interpreting electroacoustic works. However, it would be necessary to additionally consider the more 'external' manifestations of musical space related to the complexity of the performance environment, distinguishing between monophonic, stereophonic, quadraphonic, and surround, as well as acousmatic and ambisonic space, as, on the one hand, the type of acoustic technology used, and, on the other, the type of listening situation.

2.3.3. The codes of space – depth, reverberation and movement

Spatiality and auditory space are closely related to the mechanisms of human perception. While one is perceiving music, information is processed sequentially at several levels: that of acoustic hearing and that of identifying the source and its properties.[580] Sound does not have the characteristics of an object, has no boundaries and is 'invisible', but is perceived by humans as a point – a place located in space, as a sound object distinguished from its surroundings.[581] Although acoustic waves reach the listener from various directions, the listener typically perceives a single sound 'image' whose source

579 See: Young, *Networked Music…*, pp. 107–110.

580 Klawiter, Preis, *Percepcja słuchowa przedmiotów…*, p. 144.

581 According to Pierre Schaeffer, the originator of the term, a sonic object (*objet sonore*) is the smallest independent particle of a sound image, and may mean either a pure sound or an actual object.

has a fairly well-defined location within space.[582] Based on the differences in time and the intensity of the signal reaching one ear and the other, the auditory system estimates the distance and location of the sound source. Thus, the two ears play a role analogous to that of the two eyes when it comes to giving a sense of depth.[583] Sensing space is typically a process that also involves the other senses.[584] Due to the importance of the position of one's head,[585] an important role in this process is played by visual and auditory perception.[586] Also actively involved in shaping auditory sensations[587] are one's touch and the kinaesthetic sense (proprioception[588]) – space is 'touched' by sight and hearing. According to Maurice Merleau-Ponty, 'all the senses are spatial',[589] as perception is not merely the sum of the visual, tactile (haptic), and auditory, sensations, but rather a multisensory whole. The sight of a musical instrument can simultaneously call to one's mind the sound it makes, the characteristic smell, or the texture of the construction material. Similarly in music, an electroacoustic soundscape may, with its suggestiveness, have an effect on the listener comparable to that of a visual landscape.

Apart from being a vehicle for sound, the acoustic space simultaneously influences it, changing it and giving it depth. The presence of an image, on the other hand, makes one's auditory experience of

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582 Locating the source is possible due to the precedence effect, also known as the law of the first wavefront. Due to this effect, when it comes to pinpointing a sound source in a closed space, the most important wave is the one that reaches the observer first.

583 With only one ear, a person would not be capable of locating sound sources efficiently. Brian C.J. Moore, *Wprowadzenie do psychologii słyszenia [An Introduction to the Psychology of Hearing]*, translated by Aleksander Sęk, Ewa Skrodzka (Warszawa: Wydawnictwo Naukowe PWN, 1999), p. 234.

584 Ewa Rewers, *Post-polis. Wstęp do filozofii ponowoczesnego miasta [Post-polis. An Introduction to the Philosophy of the Postmodern City]* (Kraków: Universitas, 2005), p. 67.

585 Of relevance are even the shape and size of the listener's head, as spatial hearing is very sensitive – it picks up the displacement of a sound source by just 3 arc degrees.

586 Moore, *Wprowadzenie do psychologii słyszenia…*, p. 263.

587 Denis Smalley, *Space-Form and the Acousmatic Image*, *Organised Sound*, 2007, Vol. 12, issue 1, pp. 35–58.

588 Proprioception (kinaesthesia, the kinaesthetic sense, 'deep feeling') is the sense of the positioning of one's own body parts. The receptors for this sense (proprioreceptors) are located in one's muscles and tendons.

589 Maurice Merleau-Ponty, *Fenomenologia percepcji [Phenomenology of Perception],* translated by Małgorzata Kowalska, Jacek Migasiński (Warszawa: Fundacja Aletheia, 2001), p. 239.

the space much stronger, multiplying its sensory perception. This property manifests itself strongly in all kinds of audiovisual communications.[590] The soundtrack, after all, has an enormous impact on the visual layer.[591] Seeing and hearing is perceptually 'egocentric', as both the distance and the position of the sound source are relativised with respect to the perceiver. And, although perception integrates the experiences of the different senses, the space of sound is experienced in a way entirely different than that of image. Listening is more immersive in nature because, as Walter J. Ong notes:

> Sight isolates, sound incorporates. Whereas sight situates the observer outside what he views, at a distance, sound pours into the hearer (...) when I hear, however, I gather sound simultaneously from every direction at once: I am at the centre of my auditory world, which envelops me.[592]

A phenomenon observed by the eye must be within its field of vision, whereas sounds spread around, creating a sense of being inside a certain indivisible universe. Due to this, exposing the sound source may be a good way of directing the listener's attention to certain qualities of the environment (e.g. in spatial multimedia installations). The mind incessantly maintains an auditory awareness of space – the ears cannot be completely 'closed'. Moreover, sounds reach the ear from places that the eye cannot see – thus, one may estimate the size of a room and the distances to various objects even in the dark (this ability becomes more acute in blind people). It is not possible to 'disconnect' from the sound as one would do with the image. Moreover, as noted by Marshall McLuhan:

> [Acoustic space] has no centre and no margin, unlike strictly visual space, which is an extension and intensification of the eye. Acoustic space is organic and integral, perceived through the simultaneous

590 Through simple experiments, it has been demonstrated that the speech of a person filmed from a distant shot is, paradoxically, more intelligible with a high degree of reverberation than without any. See: Joseph P. Maxfield, *Some physical factors affecting the illusion in sound motion pictures*, *Journal of the Acoustical Society of America* (1931), Vol. 3, issue 1A, pp. 69–80.

591 Scott D. Lipscomb, R.A. Kendall, *Perceptual judgment of the relationship between musical and visual components in film*, *Psychomusicology* (1994), Vol. 13, issue 1, pp. 60–98.

592 Walter J. Ong. *Oralność i piśmienność. Słowo poddane technologii [Orality and Literacy: The Technologizing of the Word]*, translated by Józef Japola (Lublin: Redakcja Wydawnictw KUL, 1992), p. 105.

> interplay of all the senses; whereas 'rational' or pictorial space is uniform, sequential and continuous, and creates a closed world with none of the rich resonance of the tribal echoland.[593]

This would imply that hearing is more susceptible to all kinds of illusions.

The sonic representation of an acoustic space's properties is *reverberation* – a complex pattern of sound reflections from the walls, the ground, and surrounding objects.[594] It has a significant effect on the timbre, shape, and strength of any sound – the acoustic energy from reflected sound waves alone can be greater than that of a sound wave reaching the ears directly.[595] By differentiating between direct and reflected sound, the sense of hearing produces an impression of distance and a feeling for the size of the interior, carrying information on the obstacles present in the interior, as well as on the attenuation. Reverberation time is, therefore, one important cue when it comes to determining the size of a room, while small differences between the reverberation signals picked up by one ear and the other give the listener a basis for locating things in the space.

The connection between the sensation of spatiality and the reverberation of sounds is so strong that, by way of electroacoustic simulation of resonance, reverberation, echo, or interference phenomena, it is possible to mimic natural acoustic spaces or create entirely new ones. This is because the reverberation characteristics may convey information about the room, its size, shape, and even the construction material.[596] In this way, it is easy to fool one's intuitive ability to guess the distances by capturing the speed of sound propagation. The correct perception of acoustic phenomena is, after all, effective in the natural environment, where it has developed; if perception is

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593 Marshall McLuhan, *Wybór tekstów [Essential McLuhan]*, eds. Eric McLuhan, Frank Zingrone, translated by Ewa Różalska and Jacek M. Stokłosa (Poznań: Zysk i Spółka, 2001), p. 338.

594 Reverberation is the phenomenon of the gradual disappearance of sound after the sound source has become silent, occurring due to the reflection of sound waves from the surfaces in the room. This gives each environment its own unique acoustic characteristics: echo in the mountains, deep reverberation in a church, or negligible levels of reverberation in a small, cramped room.

595 Brian C. J. Moore, *Wprowadzenie do psychologii słyszenia*…, p. 253.

596 Chowning, *The Simulation of Moving Sound Sources*, *Computer Music Journal*, 1997, Vol. 1, issue 3, pp. 48–52.

'surprised' by a new situation (e.g. sounds are detached, abstracted, or heard in isolation or in an anechoic chamber), hearing may yield to various illusions.[597]

Another one of the key elements of perceiving music – inducing a sense of not just sonic, but also acoustic space – is the impression of movement (melodic, harmonic, textural). An opportune level of loudspeaker placement and sound directing that gives one the illusion of movement of sound sources may also lead to the creation of certain a kind of mobility – an acoustic dynamic of movement. In 1972, for his piece *Turenas*, John Chowning constructed a computer synthesis system and a quadraphonic loudspeaker system coupled with it, giving the listener the impression of movement within the acoustic space.[598] It was the first electroacoustic production of this kind.

When music is recorded or created in a professional studio, it is usually devoid of reverberation, or, to be more precise: it is created and registered so that its space factor is 'zero'. This neutrality enables spatialisation from scratch. When creating or recording multichannel, sounds can be dynamically distributed in a panorama. One may achieve this effect either after the sound has been recorded or beforehand; in the latter case – including in a concert setting – sounds are recorded using at least two microphones. This method is employed extensively in live electronics music. Multichannel recording also enables the preservation of the effect of depth (simulating the distance from the source) and perspective, which naturally spatialises the sound. There are settings – rooms, natural environments, and natural phenomena – whose audiosphere is so interesting and sonically appealing that the creator may want to preserve it faithfully. In such a case, the creator would use opportune equipment and record using more microphones. This approach is characteristic of field recording musical phonography.[599] Projects of this kind create aural landscapes of sorts, aiming to mentally transport the listener deep into their sonically-rich landscape.

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597 Albert S. Bregman, *Auditory Scene Analysis: Hearing in Complex Environments* [in:] *Thinking in Sound: The Cognitive Psychology of Human Audition*, ed. Stephen McAdams, Emmanuel Bigand (Oxford: Clarendon Press, 1993), p. 33.

598 Bertrand Merlier, *Space in Electroacoustic Music, 5.1 Surround Systems and DTS Encoding*, *Thélème Contemporain* (2009), http://tc2.free.fr/espace/articles/Conf51GB.pdf.

599 One forerunner of field recording was John Lomax, an ethnomusicologist who researched African-American culture in the 1930s and 1940s; the creator of concrete music, Pierre Schaeffer, was a continuator.

2.3.4. Illusions of space – from amplification to acoustics

Amplification – or, to be more precise, electroacoustic amplification through a sound system – is the simplest and least intrusive way to alter the spatiality of sound in the broadest sense. Owing to the use and opportune placement of loudspeakers (woofers, tweeters, mid-range, and others), the sound and colour space 'widen' and 'deepen', as the registers that are amplified are often those that are the least audible. Amplification may change the auditory context in a perceptual sense, 'moving', or 'inscribing', sounds into a different space in a certain sense, creating a hybrid acoustic space stretched between the performing stage and the 'added' electroacoustic space. At the same time, the creative potential of such musical meta-spaces (interspaces?) raises questions as to their ontological status – is it acoustic music, or electroacoustic music?

While in the case of single-speaker (monophonic) systems the source of the sound is a specific point in space, stereophonic, and even more so quadraphonic sound, is perceived as surrounding the listener.[600] In such cases, the manner of perception changes: 'Stereo is sound in depth'.[601] Stereophony emerged as early as the 1930s,[602] then dominated recording technology in the 1960s, owing to the momentum of the rapid expansion of popular music. As early as the early 1940s, the *Fanta Sound* system was developed as a forerunner of the *Dolby Surround* standard (created for home cinema in 1982) and the 5.1 Surround systems popular in our day. The aim of building such devices is to achieve an effect of sonic immersion. This idea has been with acousticians since the advent of stereophony, and, in recent decades, bore fruit in the form of omnidirectional systems and virtual sound acoustics.

The 'leap' in the technology related to sound systems – increasing the number of loudspeakers, their quality and efficiency, as well as the shift from analogue to digital media – led to the development of many new recording and playback standards, as well as a new musical trend, acousmatics. One of the groundbreaking performance tools in this field was the *Acousmonium*[603] – a set of dozens of loudspeakers of

600 In the 1980s, the popularisation of stereo headphones gave every listener the ability to attain an isolated, 'private' acoustic space.

601 McLuhan, *Zrozumieć media…*, p. 364.

602 Merlier, *Space in electroacoustic music…*

603 *The Acousmonium* was created at the beginning of the 1970s by François Bayle and Jean-Claude Lallemand of the Paris-based Groupe de Recherches Musicales (GRM).

different sizes and with different functions. The main idea behind the system was to achieve a spatial and auditory environment in which the listener would stop locating and identifying the source of the sound and only focus on its unique sonic qualities instead. The versatility of the Acousmonium allows one to play any electroacoustic composition, as well as modify and spatialise older pieces.[604] The 'conductor' of this peculiar loudspeaker orchestra is the sound director – the acoustic interpreter of the musical work.[605] IRCAM's wide-ranging research is concerned with a multitude of issues related to musical space and spatiality. Recently, this research has yielded a new tool called SPAT, able to simulate or shape the acoustics of different types of rooms.[606]

The idea of auditory immersion resulted in a search for a system that would ensure full three-dimensional sound using a relatively small number of recording tracks and speakers. Thus, Ambisonic was born – a recording format and corresponding sound system developed in the 1970s through the collaboration between Michael Gerzon[607] (Mathematical Institute, Oxford), Peter B. Fellgett[608] (University of Reading), and the now-defunct IMF Electronics.[609] This system provides control not only over the omnidirectionality of the sound, but also over the shaping of the sound in the vertical dimension (periphonic, ambisonic space). The Ambisonic system found its way into both popular works (even computer games) and serious ones. It is used by, among others, composers associated with the CCRMA centre at Stanford University (USA) studying surround sound: Fernando LopezLezcano and Juan Pampin. It has also been used successfully

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604 Similar procedures have been adapted by modern cinema, converting old films – silent, black and white, mono – to colour, surround or even 3D technology.

605 This interpretation usually involves remixing sound layers. 'Signals are split into a series of filtered sound bands and directed to the corresponding loudspeakers. The procedure makes it possible to avoid situations where certain sounds being masked by others, which is not desirable from the perspective of the listener. Thus, the sound director may "draw out" any sounds and make them audible – just as a conductor would, for instance, emphasise a viola part inaudible in other interpretations of the same piece.' Pasiecznik, *Acousmonium* [in:] *Otwarte archiwum tekstów o nowej muzyce* [blog], 20/08/2012, http://monikapasiecznik.blogspot. com/2011/08/acousmonium.html.

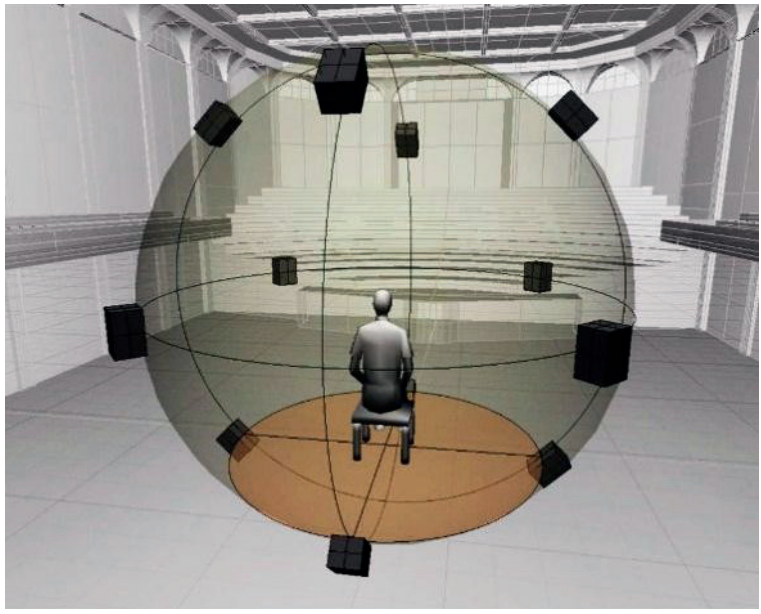
606 See: http://www.fluxhome.com/products/plug_ins/ircam_spat.

607 Michael A. Gerzon, *Ambisonics in Multichannel Broadcasting and Video*, *Journal of the Audio Engineering Society* (1985), Vol. 33, issue 11, pp. 859–871.

608 Peter B. Fellgett, *Ambisonics*, *New Electronics* (1981), issue 5, pp. 38–48.

609 See: http://www.imf-electronics.com/Home/imf/ambisonic.

by Ewa Trębacz, a Polish composer living and working in the United States. The overarching idea of her work is to achieve an effect of sonic immersion, in which the listener would not perceive any boundaries between virtual and real space, or between synthetic and natural sound sources. In such settings, 'the aesthetic situation integrates the spatial and temporal features, relegating the problems of veracity inherent in cognitive realisation to the background'.[610]



Example 30. A diagram of the loudspeaker layout in an Ambisonic system

The Ambisonic sound system is employed by Lidia Zielińska (*In the Rear* and *Backstage Pass* from 2010) and Krzysztof Gawlas (*Spherical Voices* from 2010) in concert performances of their electroacoustic works.

The 20th century saw the development of many similar standardisations when it came to recording techniques, sound systems, and the internal architecture of recording studios. The acoustic characteristics of concert halls, however, have not been approximated to a sufficient degree, so performers and sound engineers must treat almost every concert as a new acoustic setting. With the right sound direction, it is possible to partially 'adjust' to the performance space, but there

610 Teresa Pękala, *Czas miniony jako doświadczenie przestrzeni [Time Gone by as an Experience of Space]* [in:] *Czas przestrzeni*…, p. 431.

are times when even the best sound systems fail in interiors whose acoustics are not favourable. In the case of new spatial music projects, in order to anticipate such problems, a target performance venue is established in advance, even before commencing the composition process, or the composition is 'dedicated' to an environment with specific, unique acoustics.

When it comes to the spatialisation of music, new media play a key role. This is because they make it possible to manipulate any of the sound effects – delay lines, reverberation, dynamics, and distance simulation – that are involved in creating musical depth, as well as, movement in space, already at the stage of processing and digital recording. One of the first to use computer-assisted spatialisation was Pierre Boulez in his *Répons* for 6 soloists, chamber orchestra and live electronics (1981). Developed in 1979 at IRCAM, the 4X[611] system continuously processes the parts of the six soloists positioned around the orchestra, creating an effect of echoes circulating around the room.[612]

2.3.5. Intermedia, virtual, and interactive spaces

The situation of the contemporary composer entering the mediatised 21st century increasingly presupposes an interdisciplinary approach to art. In fact, it is not difficult to notice the tendency to constantly cross the boundaries of media in artistic practice.[613] Culture has become a multi-sensory and multi-dimensional space – for the receiver of a multimedia message, meanings may arise not only from each separate modality, but also between them. This peculiar place of interaction (and synergy) between different media may be called an *intermedial* space.

It becomes an important area of interpretation when the relationships (interplay, interaction) between the media used – the crossing of all sensory experiences, the overlapping of the planes of auditory, visual, tactile, or olfactory messages – become the foundation of the

611 The 4X was the first digital computer system to permit the free shaping of the sound spatialisation during both creative work and performance. In addition to Boulez, it was used by people like Luigi Nono and Karlheinz Stockhausen.

612 See: Pierre Boulez, Andrew Gerzso, *Computers in Music*, *Scientific American* (1988), Vol. 258, issue 4, http://articles.ircam.fr/textes/Boulez88c/.

613 Interdisciplinary tendencies are evident in both artistic creations and theoretical reflection constituting a response to them. Cf. Magdalena Wasilewska-Chmura, *Przestrzeń intermedialna literatury i muzyki [The Intermedial Space of Literature and Music]* (Kraków: Wydawnictwo Uniwersytetu Jagiellońskiego, 2011), p. 25.

work. This holds especially true for new art forms and genres such as performance, installation art, or soundscape. Sound sculpture installations are an expansion of three-dimensional space different from that of sculpture proper, because they go 'outside', resonating and 'dialoguing' with their surroundings. Sound, on the one hand, 'sculpts' the space[614] and, on the other, extends the spatial boundaries of the sculpted objects, becoming a mediatised space and a spatial interface. In the aesthetic experience of such a space, acoustic sensations are just as important as visual, olfactory, or kinaesthetic impressions.[615] The installation has thus become an expansion – a media 'extension' – of the three-dimensional space; it is (in contrast to traditional sculpture) an open space, dialoguing with its surroundings, which fall within its conceptual scope. Furthermore, being able to enter the installation's space allows one to assume different perspectives and points of view and hearing.

When a work of art – be it visual or auditory – is the object of aesthetic experience, it is able to transcend its actual location in relation to the observer and other objects, giving one the impression of a separate, illusory space: 'one might show, for example, that aesthetic perception too opens up a new spatiality, that the picture as a work of art is not in the space which it inhabits as a physical thing and as a coloured canvas'.[616] Owing to its suggestiveness, the electroacoustic soundscape is able to affect the listener like a visual landscape would. That which is depicted in a work of art 'reveals to us aspects of being inaccessible in any other way, opening us up to a new world'.[617] In the aesthetic experience, therefore, the real space and the space attributed to the work, the intentional space, always meet. Owing to electronic tools, this situation is often extended by a new aspect, as the target

614 Takao Hensch, Tania Rinaldi Barkat, *Sculpting Sound Space in the Developing Brain* (Harvard University, 2011), https://www.mcb.harvard.edu/mcb/news/news-detail/3581/ sculpting-sound-space-in-the-developing-brain/.

615 Michał Podgórski, *Przestrzeń miejska – dzielenie postrzegalnego. Próba analizy procesów zawłaszczania przestrzeni miejskiej z perspektywy filozofii Jacquesa Rancière'a [The City Space – Dividing the Perceptible. An Attempt to Analyse the Processes of City Space Appropriation from the Perspective of Jacques Rancière's Philosophy]*, *Interlinie*, 2011, issue 1, p. 8.

616 Merleau-Ponty, *Fenomenologia percepcji*…, p. 312.

617 Piotr Schollenberger, *Przestrzeń w doświadczeniu estetycznym dzieła sztuki [Space in the Aesthetic Experience of a Work of Art]* [in:] *Czas przestrzeni*…, p. 327.

musical space may be impossible to obtain naturally, artificial, or inaccessible in reality; it may be a virtual simulacrum, or, to use another expression, an *acoustic cyberspace*.[618] This creation of listening

spaces from scratch has long been used in cinematic fantasy, and, on a larger scale, in computer games. The viewer is confronted with an imaginative musical space intended to give rise to a new, more powerful aesthetic experience.

Phonography made it possible to record and reproduce a performance, liberating the audience from live contact with the music. But it is only modern, digital equipment that is able to process sound so precisely as to, by using a suitable sound system, either in a concert setting or at least in stereo headphones, make it possible to evoke a sense of presence in any acoustic space for the listener. Indeed, in a recording, the spatial conditions of a performance may be fixed or so modified as to create the illusion of a completely different place. One artist to take it a step further was Patrick Ascione, a French composer of electroacoustic music. Since 1987, in his works and projects, he pursued the idea of 'polyphony of space' (not to be confused with spatial polyphony). Its first realistation came in *Espaces-paradoxes* (1989), composed of 16 different soundtracks in which different acoustic-musical spaces collide simultaneously.

Each venue boasts its own unique acoustics and audiosphere. Modern recording techniques are able to capture even the quietest ambient noises, then amplify or process them later. Thus, the space itself is able become a source of sound, a musical instrument. The main artistic aim of Brian Williams (releasing records under the pseudonym 'Lustmord'), a pioneer of the dark ambient current, is to record or imitate the sounds of specific spaces, especially underground ones, such as caves, catacombs, shelters, ships, etc. In composing his pieces, he employs his knowledge of psychoacoustics and physiology in order to influence the listener's mood.

The ability to faithfully reproduce, imitate, hybridise, or create acoustic spaces has given rise to new musical currents, including field recording, soundscape and ambient. Another new phenomenon in this area are virtual concert halls,[619] which allow people to parti-

618 See: Tomasz Misiak, *Od przestrzeni akustycznej do akustycznej cyberprzestrzeni [From Acoustic Space to Acoustic Cyberspace]* [in:] Misiak, *Estetyczne konteksty audiosfery*...

619 Birgit Stöber, *New Media and Music Products "Any Place and Any Time": The Digital Concert Hall in a Media Geographical Perspective*, Copenhagen Business School, Frederiksberg 2011, pp. 2–24, http://openarchive.cbs.dk/bitstream/handle/10398/8253/54-BS-%20New%20 media%20and%20 music%20productsx.pdf?sequence=1.

cipate in a live broadcasted performance via Internet connections. Performing music in a virtual space[620] abolishes real distances and boundaries, permitting the telepresence of internet listeners.

Multimedia communication technologies have shaken up the basic dimensions of reality – that is, space and time. One could say that these dimensions have shrunk, as the same communication possibilities are accessible from different locations. One of the composers to take advantage of this was Bill Fontana, in his famous project *Distant Trains (Entfernte Züge)*[621] from 1984. This sound sculpture of sorts consisted in filling an empty square in the centre of Berlin – where the Anhalter Bahnhof, one of Europe's largest railway stations before World War II, was located – with realistic sounds. Through a hidden, underground public address system, sounds transmitted directly from the Hauptbahnhof – a busy train station in Cologne – were emitted. The telematic sound message, inscribed in a strongly historical and cultural context, thus became a virtual acoustic setting, a historical sound snapshot, or 'a space haunted by sounds and acoustic memories',[622] as the project's author wrote. Fontana's installation created a space of transition, a sonic inter-space, intended to stimulate the ability to imagine one's presence in another place and another time.

The media change the way one interacts with space on a physical and intellectual level. Through the use of proximity sensors, motion sensors, temperature sensors, etc., a certain area of real space may be made *interactive*. This is due to the fact that sensor parameters may be converted digitally into any other data and, for example, control electroacoustic devices (this activity is usually called 'mapping'). The dedicated space then becomes a kind of virtual musical instrument[623] in which the stimulation of specific 'sensitive' areas through movement, light, or other recordable factors may become the equivalent of a musical performance – a sound spectacle. This

620 Linda Rogers, *Future of Work: Musical Performance in Virtual Reality*, h+, 19 November 2012; the author is an organiser of musical performances in the virtual environment of Second Life, http://hplusmagazine.com/2012/09/19/invited-essay-future-of-work-musical-performance-in-virtual-reality-music-island-five-years-of-virtual-concerts-in-the-park/.

621 See: http://resoundings.org/Pages/Bill_Fontana_Project_Library.html.

622 *In Conversation: Bill Fontana and Ben Borthwick* [in:] *The Hothaus Papers: Perspectives and Paradigms in Media Arts*, ed. Joan Gibbons, Kaye Winwood (Birmingham, ARTicle Press, 2006).

623 Christopher Dobrian, *Aesthetic Considerations in the Use of "Virtual" Music Instruments*, *The Journal of the Society for Electro-Acoustic Music in the United States*, 2010, Vol. 16, p. 28, http://music.arts.uci.edu/dobrian/motioncapture/DobrianAestheticConsiderations.pdf.

strategy is often found in audiovisual performances, where movement triggers sound using electronic media. Here, the musical space cross-pollinates, converges, and merges with the visual space; their relationship becomes an element of intermedia play. The first such interactive spaces date back as far as the 1960s,[624] only to reach the peak of popularity several decades later. In *Very Nervous System*, developed since 1986 by David Rokeby, the performer's actions are analysed by the computer via a video camera. The interactive, virtual space created by the work requires dance-like movements in order to be 'played', making the staging of the installation a performance. An analogous example of an interactive sound space when it comes to Polish art may be the project initiated by Denis Kolokol, *Sympli Romatikó*. 'The hand of the person playing,' describes the creator, 'attracts the drifting sounds, literally grabbing them and charting their trajectory in space. The latter, in turn, is all organised according to a scale, which turns it into one big, ephemeral instrument that may be played without touching a key or string, instead just dancing.'[625] The dynamics of this interactive system are sensitive to the initial conditions and to the slightest nuances of one's movements. Here, the interactor may get the impression of 'touching the sound', through which they intuitively build the auditory layer of the piece. A similar example of a spatial, virtual instrument is the *ISA Harp* constructed in 2008 by Peter Sych and Lisa Lang.[626] One may call it a virtual harp, with 16 invisible vertical and horizontal strings – infrared beams – forming a motion-sensitive grid (any disturbance to the beam is converted into control data). The instrument is used in a variety of applications – it may, for instance, be used as a virtual console for playing, mixing and conducting recordings. It has been used several times in the artistic activities of Marek Chołoniewski and Krzysztof Knittel.

The Internet and its networked cyberspace are increasingly becoming the virtual venue for musical interaction. The web makes it easy for an artist to communicate with the audience and incorporate their actions into the project being carried out. However, it is difficult

624 Among others, *Sounding* by Robert Rauschenberg and Billy Klüver (1967), *Field Piece* by Barbara Smith (1969), and the interior of the Pepsi Pavilion presented at the 1970 Osaka World Expo, whose centrepiece was an interactive, spatial light and sound system.

625 Denis Kolokol, commentary on the *Sympli Romatikó* project, http://www.news.cricoteka.en/polifonie/.

626 Cf. http://isanewmedia.blogspot.com.

to speak of the existence of some forms of interactive musical space. Here, the composer is usually the initiator or moderator of a piece project which, once launched, begins to 'live its own life'.

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Electroacoustic music is moving towards an increasing emancipation of the musical space as a formative element of the work, as new media have made it possible to simulate, but also 'produce',[627] any acoustic space. All aspects related to it have become more easily to grasp and shape for the creators. Computer software, effect processors, and note editors permit the composer to visualise, transform, modify, and therefore control the entire musical space. In conclusion, one may make an attempt to assign the concepts discussed to areas of compositional activity related to new media:

Table 2.
Typology of musical spaces

Concept / type of space	Technologies / new media	Scope of meaning	Genres, forms and currents
Sound space	Algorithmisation and electroacoustic filters	Sound material and ambitus	Algorithmic compositions
Spectral space	Spectrogram, computer analysis, and synthesis	Colour and spectrum	Spectralism
Acoustic space	Amplification, effects processors, and sound systems	Acoustics and reverberation	Any
Audiosphere	Analogue and digital recorders	The totality of sound phenomena	Soundscape and acoustic ecology
Virtual space	Computer synthesis, sound direction, and sound systems	Sonic immersion	Ambisonics and acousmatics
Intermedia space	Multimedia and interactive computer systems	Relations between the media and multimedia messaging	Installation, performance, and sound sculptures

New media and the technologies associated with them have radically changed the way we think about the music space. The way it is analysed, shaped, and perceived has shown just how many possibilities, but also problems, are opening up. This rendered the traditional

627 Karina Banaszkiewicz, *Krajobrazy, pejzaże, widoki i maszyniczne systemy wytwarzania przestrzeni [Sceneries, Landscapes, Views, and Machine Systems for Creating Spaces]* [in:] Banaszkiewicz, *Audiowizualność i mimetyki przestrzeni [The Audiovisuality and Mimetics of Space]* (Warszawa: Oficyna Naukowa, 2011, p. 213).

division between spatial arts, which include painting, sculpture and architecture, and temporal arts, such as music, inadequate. New media enabled something composers could only have dreamed of before: the simultaneous juxtaposition of different types of musical space and the consequent shaping of entirely new sonic, acoustic, perceptual and aesthetic settings.

The interest in space and spatiality, as well as the desire to reinterpret them artistically, is strongly present in all genres of contemporary sound art. Ever more often, works take on hybrid forms, combining a variety of sonic, but also visual and tactile media, and thus different, multidimensional spaces. At the intersection of these spaces, new aesthetic experiences and a new sensibility are born, which will be discussed in the next chapter. Owing to new media, the possibility of 'playing' with musical spaces can finally become interesting enough to constitute not just an equal, but also a fundamental element of a piece.

2.4. From 'hearing culture' to 'multimedia sensibility'

For modern science and its various fields, the mechanism of human perception of the world is still an inscrutable, though strongly debated problem. In the context of art, this issue seems to be of paramount importance, as it provokes a number of questions. What happens in the mind of a human being in contact with art? How does the human mind perceive, interpret, and value works of art? How does one understand beauty in terms of human perception? This issue, when placed in the context of the specificity of contemporary music and art – electroacoustic, multimedia, interactive – gives rise to even more difficult questions: how does one's hearing and the mind wielding it react to new, synthetic sounds? What are the mechanisms of multisensory perception? Are new perceptual skills being developed in the face of new aesthetic settings? In recent decades, attempts at delivering answers have been brought by newly emerging branches of science, especially those with an interdisciplinary and cognitive orientation – psychoacoustics and character psychology, but also neuroscience and neuroaesthetics. These just prove that man, in the age of new media, is taking another step on the long road of his 'sensory evolution'.

2.4.1. The whole is more than the sum – the possibilities and limitations of perception

Perception is one of the main functions of the human mind. Its role is to constantly process the sensory stimuli received, organise them into stable impressions and observations, and then to make sense of them and create its own understanding of the reality experienced. Thus, perception is an internal, subjective interpretation of the external world. This process is based on specific activities, i.e. seeing, hearing, tasting, smelling, touching, feeling temperature, etc., which are responsible for constructing observations. But, owing to memory and the internal dynamics of the mind, complex internal states may also arise without direct interaction with the world. Maurice Merlau-Ponty even states that 'there is no (...) difference between thinking and perceiving.'[628] As emphasised by Tomasz Zarębski:

> The world is not given to us in the form of individual pieces of sensory data, and even if it were, we would not be able to understand – without falling victim to the myth of data – how concepts and judgements may arise from purely causal impressions. The world is experienced by us and the minimum starting point for knowledge is precisely experience, which is already conceptual in nature.[629]

The percipient mind is constantly checking the beliefs it formulates; it decides whether to accept a given judgement, temporarily suspend it or reject it. Many of these processes belong to the group of subconscious phenomena, which not only cannot be directly controlled, but which also, even in the face of the possibilities of modern science and technology, cannot be fully investigated and understood.

When it comes to analysing the process of perception, twentieth-century psychology has adopted two basic strategies. The first one focuses on feature extraction, in line with the position that the essence of perception is the integration of simple components into a complex whole. Each time, the perceived object is compared to invariant patterns – cognitive representations fixed in memory. The other concept emphasises the creation or discovery of an object through a process of perceptual organisation, based on knowledge and inference. This

628 Merleau-Ponty, *Fenomenologia percepcji*…, p. 233.

629 Tomasz Zarębski, *Sellars i McDowell o percepcji i wiedzy empirycznej [Sellars and McDowell on Perception and Empirical Knowledge]* [in:] *Percepcja. Między estetyką a epistemologią [Perception. Between Aesthetics and Epistemology]*, eds. Roman Konik, Damian Leszczyński (Wrocław: Oficyna Wydawnicza „Atut" – Wrocławskie Wydawnictwo Oświatowe, 2010), p. 92.

process combines attitudes, expectations, and acquired experiences encoded in cognitive structures (sounds and music may carry aesthetic and emotional-expressive qualities, but also functional signals[630]). During the perceptual categorisation phase, the brain refers to a store of ready-made innate schemas and 'generalisation' schemas employing archetypes, while taking in a variety of information and trying to combine and organise it so that it may carry meaning and sense. Extracting the subject from its environment – separating the figures from the background – is a prerequisite for this mechanism and a basic tenet of Gestalt, or character psychology.

The most important and sensitive human senses are s i g h t and h e a r i n g, categorised among the long-distance senses. It is important to note that auditory and visual stimuli convey quite different qualities. Hearing is able identify the elements of a sound (e.g. a set of instruments) while sight cannot distinguish between the components of colours. Moreover, not unlike sight, hearing may be very selective and, among the many sounds it perceives, may focus on one while ignoring the others (e.g. following one of the voices in a polyphonic fugue texture[631]). In the practice of everyday life, however, the audio component and the visual component do not carry the same weight. The mind primarily deals with visual stimuli, from which it acquires more than 80% of the information coming from the surrounding space. Furthermore, it has been estimated that 70% of all brain neurons are involved in image processing, with more than one fourth of the brain involved almost exclusively in receiving visual impressions.[632] According to research, the sense of hearing provides the brain with but a small part of the information of the comprehensive perceptual signal.[633] However, it must be emphasised that, notwithstanding the dominant role of sight, the senses of vision and

630 See: Björn Vickhoff, *A Perspective Theory of Music Perception and Emotion* (Göteborg : University of Gothenburg, 2008).

631 This mechanism, known as the cocktail party effect, is related to the selectivity of attention and the ability to locate sources of sounds. It involves focusing on the acoustic message of interest to the listener (monologue or dialogue surrounded by additional sound sources) while ignoring (usually unconsciously) the acoustic information reaching the listener from other places. The mind is able to decompose the surrounding acoustic setting into individual streams and thus make a selective choice between them.

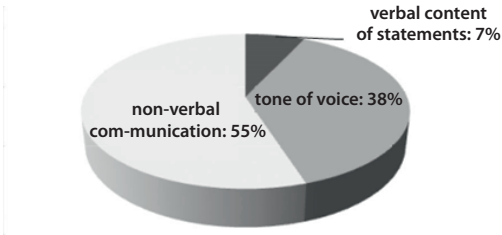
632 Aleksandra Kowalczyk, *Badanie spostrzegania krajobrazu multisensorycznego – podstawą kształtowania obszarów rekreacyjnych [Study of the Perceptions of the Multisensory Landscape – the Basis for Shaping Recreational Areas]* (Bydgoszcz: Wyższa Szkoła Pedagogiczna, 1992), p. 2.

633 Kowalczyk, *Badanie spostrzegania...*, p. 2.

hearing complement each other perfectly, forming an integral system. Hearing, writes Merleau-Ponty, 'presents us, beyond the sounds in space, with something which "murmurs", and in this way communicates with the other senses.'[634] Sight is at the forefront of object recognition, but, oftentimes, it is hearing that directs attention to the objects being sought; hearing is auxiliary to sight, but it is essential to it – it hears what the eyes are unable to see. This is related to another quality highlighted in the essence of the sounds – temporality.

The engagement of two senses at the same time increases the power of the message disproportionately. While receiving music without an accompanying image is a natural and psychologically comfortable activity, a moving image without sound is difficult to accept. It is natural for one's imagination to create images to accompany the music being listened to, but it seems much more difficult to mentally 'compose' the music to accompany an image. Musical cognition is, indeed, not a matter of pure auditory experience. Sometimes, sound is only understandable in the context of seeing its source.

One breakthrough when it came to understanding audiovisual perception in the perspective of interpersonal communication were the findings of the American psychologist, Albert Mehrabian; at the dawn of the 1970s, based on his own research, he came up with a formula showing the influence of verbal and non-verbal stimuli on the overall interpretation of transmitted information.[635] Mehrabian came to the conclusion that only about 7% of human communication was based on words.



Example 31. The '55/38/7 rule' regarding communication and perception

634 Merleau-Ponty, *Fenomenologia percepcji*…, p. 251.

635 See: Albert Mehrabian, *Silent Messages* (Belmont: Wadsworth, 1971).

In our day, psychologists question the credibility of his experiments due to the overly 'laboratory' conditions in which he carried them out.[636] Nonetheless, Mehrabian's theses inspired a series of various kinds of research to help unravel the mystery of how the non-verbal part of a message is perceived. Everything seems to suggest that the analysis and recognition of the gestures used during the conversation leads to their confrontation with one's own experiences. In other words, the viewer automatically gets in tune with the state of the speaker, knowing how they would have to feel if they were to use the same gestures. When it comes to the reception of performing arts, this is an important fact. In contact with music, the process works analogously, which plays a significant role when one watches a live performance. One may practise the ability to concentrate both in general and focusing on a selected perceptual channel, but listening or seeing separately is not possible – the mind sees, listens, and feels at the same time. This is part of why for an artist, especially a contemporary artist, knowledge of perception and the context of perception is indispensable.

2.4.2. The universals of hearing – perception in the perspective of the auditory scene theory

The amount of sensory data coming into contact with a human being is so great that the brain would not be able to process and interpret it all. Due to this, the capabilities of hearing, like the other senses, are conditioned and limited at the psychophysiological level. Hearing makes selections both at the 'corporeal' level[637] and 'at higher levels of hearing'; physiology alone is not able to fully explain all the functions of the perceptual apparatus.[638]

Hearing is a complex process, involving a long chain of highly specialised mechanisms.[639] New light was shed on the psychoacoustic secrets of perception by Albert Bregman's theory of the auditory

636 Paweł Fortuna, Dariusz Tarczyński, *Sens i nonsens komunikacji niewerbalnej: Reguła: 55/38/7, [The Sense and Nonsense of Non-verbal Communication: The 55/38/7 Rule]* 6/06/2006, http://kadry.nf.pl/Artykul/6730/Sens-i-nonsens-komunikacji-niewerbalnejRegula-55–38-7/Komunikacja-niewerbalna-mowa-ciala-rozwoj/ (access: 21 July 2014).

637 When it comes to frequency, for example, one's capability of hearing ranges between 16 Hz and 20 kHz.

638 Eric David Scheirer, *Music Perception Systems* (Cambridge: Massachusetts Institute of Technology, 1998), p. 38.

639 Daniel Williamson, *Perception of Music* (Houston: Connexions, Rice University, 2009), p. 1.

scene.[640] This theory fits in with the new current of cognitively-oriented musicology, which, in describing phenomena that are difficult to conceptualise, applies rules borrowed from cognitive psychology and Gestalt psychology.[641] The theoretical description and practical application of the analytical possibilities of Bregman's auditory scene were extensively presented by Justyna Humięcka-Jakubowska in her work *Scena słuchowa muzyki dwudziestowiecznej [The Auditory Scene of Twentieth-Century Music]*.[642] Moreover, the author attempted to adapt these new analytical methods to the music of the latter half of the 20th century, including Polish music. In the words of Humięcka-Jakubowska, the auditory scene is:

> The acoustic environment of auditory perception in general, in which the perceiver of the acoustic situations originating from this environment attempts to construct descriptions of these situations as well as to determine which parts of the sensory stimuli provide him/her with knowledge about a given environmental object or event.[643]

At the same time, auditory scenes are temporal sound sequences characterised semantically.[644]

Bregman's theory assumes the formation of auditory forms of music (*Gestalten*) while one is listening to music. Perception encompasses the stage of cognition during which one forms the image of a musical work – a mental representation thereof. It is made up of dynamic images, sustained for a while, then changing and, in the end, fading away. Involved in the formation of the individual perceptual representations are attention and memory, whose role is to

640 Bregman, *Auditory Scene Analysis*...

641 The Gestalt current emerged in German psychology, in the first half of the 20th century. This innovative theory of perception re-evaluated our knowledge concerning the relationship between the whole and its constituent parts, how the whole and its parts are perceived by the mind, and how the whole as a figure emerges from the background. Cf.: Kurt Koffka, *Principles of Gestalt Psychology* (New York: Harcourt, Brace, Routledge and Kegan Paul, 1935); Max Wertheimer, *Productive Thinking* (London: Tavistock, 1945).

642 Justyna Humięcka-Jakubowska, *Scena słuchowa muzyki dwudziestowiecznej [The Aural Scene of Twentieth-Century Music]* (Poznań: Rhytmos 2006), p. 84.

643 Humięcka-Jakubowska, *Scena słuchowa…*, p. 83.

644 Rui Cai, Lie Lu, Alan Hanjalic, *Co-clustering for Auditory Scene Categorization*, *IEEE Transactions On Multimedia*, 2008, Vol. 10, issue 4, p. 596.

constantly supplement the signal.[645] The mind constantly refers back to experiences stored in the form of neuronal spectrograms,[646] which makes knowledge from previous experiences of great importance.

One of the most important functions of the auditory system is perceptual grouping, the segregation and fusion of signals associated therewith, and masking.[647] A series of identical sound events evokes a sense of perceptual wholeness, which one might call character formation. Depending on the style of music, the structure of the perceptual sound figures is determined by different parameters.[648] Rather than to the principles of organisation fixed in the score, the organisation of the mental representation and the auditory scene of a musical work refers to the auditory experience. The basic structural units of a work shown in notation are a source of imagery for visual figures whose forms differ from the integrals experienced auditorily. This problem becomes apparent when examining, for example, the score for an electroacoustic work for an electronically-modified instrument. In such cases, the score of the parts for this instrument and the related sound associations may be far from the actual aural results perceived during the performance. Humięcka-Jakubowska adds:

> The perceived *Gestalten* are not necessarily the same as sound structures, as there is a whole system of transformations performed by the perceiving mind along the way. The natural features of musical representations being established segments of the current sound waveform (e.g. single or complex tones, pitches, chords, rhythmic figures, phrases, or even more developed sequences), constitute perceived and emergent qualities, such as timbre, structure, or contour. These qualities may not be presented locally, at any chosen point in time, but rather as holistic images of the entire musical object.[649]

645 Importantly, auditory memory seems to be even more automatic than preperception. While one is perceiving, sequencing sounds is more important than isolating structures. Humięcka-Jakubowska, *Scena słuchowa…*, p. 74.

646 Bregman, *Auditory Scene Analysis…*, p. 8.

647 See Urszula Jorasz, *Selektywność układu słuchowego [The Selectivity of the Auditory System]* (Poznań: Wydawnictwo Naukowe UAM, 1999).

648 Cf: James Tenney, Larry Polansky, *Temporal Gestalt Perception in Music*, *Journal of Music Theory* (1980), Vol. 24, issue 2, pp. 205–241.

649 Humięcka-Jakubowska, *Scena słuchowa…*, p. 65.

One of the constitutive principles when it comes to Gestalt psychology is the belief that the whole is more than the sum. Hence, treating music and the musical work as an organic construction whose structural analysis should be extended by a description of the overall process.

A natural, indispensable object for the functioning of attention, involving the mechanism of sequential (horizontal, melodic) and simultaneous (vertical, harmonic) grouping, is the perceptual stream.[650] In order for several different events to be fused into a single auditory stream, they need to fulfil a series of universal rules – the laws of pithiness.[651] At the same time, the strategies of the perceptual mechanisms also consider conformity with previously learned patterns (e.g. spontaneous search for tonality in music) and referring to certain memorised invariants (e.g. sounds of familiar instruments).

Although the listener is largely in control of their own attention, some phenomena attract the senses more than others. Indeed, one hears not so much with their 'ears' as with their mind and 'brain'.[652] Everyone has genetically programmed perceptual capabilities, but these do not remain invariable for all of one's life.[653] New situations and life experiences underpinning the learning process may lead to changes to these abilities, but also shape one's tastes and sensibilities. The stream of overlapping sensory signals is processed in a manner consistent with the habits that one has previously acquired. Perception, and not only auditory at that, is therefore inextricably linked to memory, which leads to the simple conclusion that it may be successfully trained and shaped.

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650 Bregman, *Auditory Scene Analysis…,* p. 47.

651 Pithiness is the tendency to perceive multiple sensations and stimuli in a way that organises disparate elements into a stable and coherent form in the simplest of ways. The mechanism of pithiness was first described by Max Wertheimer, one of the pioneers of character psychology. See: Iwona Lindstedt, *Sonorystyka w twórczości kompozytorów polskich XX wieku [Sonoristics in the Works of Polish Composers of the 20th Century]* (Warszawa: Wydawnictwa Uniwersytetu Warszawskiego, 2010), pp. 168–169; also [in:] Bregman, *Auditory Scene Analysis…,* pp. 142, 159.

652 Jorasz, *Selektywność układu*…, p. 105.

653 Perceptual abilities depend on one's individual personality development, upbringing, intelligence, education, etc. Many researchers stress that perceptions are co-constituted by environment (even climate), tradition, culture and, above everything else, language. See: Julien Knebusch, *Art and Climate (Change) Perception: Outline of a Phenomenology of Climate* [in:] *Sustainability: A New Frontier for the Arts and Cultures*, red. Sacha Kagan (Frankfurt am Main: Verlag für Akademische Schriften, 2008), pp. 242–261.

Shaped by natural evolution, the possibilities of hearing have remained the same over the past millennia, but musical perception – as a specialised skill and interpretative process – has already managed to change markedly within the last century. The human mind continuously assimilates and develops new cognitive patterns. Once a new musical style spreads – first, among composers, then, later, among the listening public – the way it is perceived also changes. During his lifetime, Chopin's music was referred to as a 'splitting cacophony'.[654] The works of Richard Strauss, Richard Wagner, Max Reger or Gustav Mahler seemed atonal and disorderly to their first listeners as well. Today, they are no longer viewed this way. Thus, the perception of music is governed by universal cognitive mechanisms on the one hand, and strongly conditioned by culture on the other.[655] The way we listen to music somehow changes alongside the music itself.

In the case of contemporary music, especially electroacoustic music, there is a lack of universally-accepted perceptual models, hence the greater cognitive and interpretive difficulties for the untrained,[656] who are only able to rely on the simplest, universal mechanisms. However, cognitive schemes can be dictated or conceptualised by a third party – such as a composer, theorist or critic, perceiving musical order faster than a layperson[657] – or supported by visual stimuli. Such pre-imposed data may have a significant impact on perceptions.

In most of the compositional techniques used in electroacoustic music, creators do not make use of principles of organisation that refer to established cognitive patterns. A heavily varied material, surprising the viewer with musical and non-musical sounds, is ordered primarily by a 'bottom-up', primitive aural organisation.[658] In such cases, not just an interaction, but also a competition occurs between the psychoacoustic mechanisms that determine such organisation. Among the factors inducing perceptual grouping through

654 Nicolas Slonimsky, *Lexicon of Musical Invective* (New York: Coleman-Ross, 1953), p. 84.

655 Timothy C. Justus, Jamshed J. Bharucha, *Music Perception and Cognition* [in:] *Stevens' Handbook of Experimental Psychology*, Vol. 1: *Sensation and Perception*, ed. Steven Yantis, Harold Pashler (New York: Wiley 2002), p. 492.

656 Petra G. Lengger et al., *Functional Neuroanatomy of the Perception of Modern Art: A DC-EEG Study on the Influence of Stylistic Information on Aesthetic Experience*, *Brain Research*, 2007, Vol. 1158, pp. 93–102.

657 Lee Humphries, *Atonality, Information, and the Politics of Perception*, http://www.thinkingapplied.com/tonality_folder/tonality.htm.

658 Humięcka-Jakubowska, *Scena słuchowa…*, p. 10.

competition, the strongest criterion is proximity to pitch, followed by timbre, then the spatial source, and, the weakest, the trajectory of changes in the physical parameters determining specific sensory features (e.g. the absence of regular rhythmic pulsation causes the perceiver to experience a continuum of fluctuating tones[659]).

Perception, especially in the absence of adequate cognitive schemes, typifies and organises sounds chiefly in terms of movement: 'sound is seen as arranged in a multidimensional space in which time is one dimension and frequency is another, analogous to a spectrogram'.[660] Therefore, the perceptual organisation of the auditory experience may be visualised representatively by means of computerised spectral and loudness amplitude analysis,[661] which may constitute a convenient alternative to musical notation and the only form of illustrating a piece of music functioning without a score. Iwona Lindstedt, too, emphasises that perceptual analysis – including auditory scene analysis – and acoustic analysis are 'important tools to aid the understanding of a musical work flowing from the score, with the latter not being a direct representation of its sound properties'.[662]

Based on Gestalt psychology, the auditory scene theory is a universal concept that does not contradict the more general principles regarding multisensory perception – the laws of grouping may be applied to different types of messages. Many of the laws established by Gestalt psychology and Bregman's theory may therefore be applied to the process of analysing electroacoustic music and multimedia art.

2.4.3. Experiencing beauty – perception from a neuroaesthetic perspective

Neuroaesthetics, a cognitive discipline applying axiological reductionism, sees humans as 'physicochemical entities' and describes them in naturalistic terms, including in the context of evolutionary adaptation.[663] It aims to explain the phenomenon of art and the ways in which it is experienced and the fundamentals of aesthetic experience, as well as to scientifically explain the mechanisms of perception in the context of neuronal and neurobiological processes. Neuroaesthetics

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659 Humięcka-Jakubowska, *Scena słuchowa…*, p. 125.

660 Humięcka-Jakubowska, *Scena słuchowa…*, p. 101.

661 See: *Analytical Methods of Electroacoustic Music*, ed. Mary Simoni (New York, London: Routledge, 2006).

662 Lindstedt, *Sonorystyka…*, p. 169.

663 Katarzyna Zahorodna, *Neuroestetyka – sztuka a mózg [Neuroaesthetics – Art and the Brain]* [in:] *Percepcja. Między estetyką a epistemologią…*, p. 152.

assumes that the admiration of beauty does not actually concern the objective world, but only certain forms of cognitive representations, adaptive and typical of the human species. The phrase 'to please' acquires a different meaning and, within the sciences of the cognitive paradigm, denotes the degree of stimulation of the dopaminergic system (reward mechanism) situated in the limbic system.[664]

The study of the brain's response to art and music became one of the ways to investigate the relationship between perception and the perceived sensations.[665] Art extends cognition, as the essential tool for its reception and understanding is abstraction, i.e. the ability to generalise, to go beyond single instances; it is a kind of 'exploration of the cognitive system'.[666] The search for the 'aesthetic mind' and the study of the neuronal determinants of aesthetic emotions is being carried out by people like Semir Zeki. He emphasises the strong links between art and cognition, placing the equals sign between the artist and the brain researcher, the 'neuroscientist' who recognises the brain's capacities and abilities, although both do so using different tools: 'the artist is an "unconscious neurobiologist" and the artwork is a super-stimulus, stimulating specific functional modules in the viewer's brain'.[667] At the same time, Zeki is confident that 'how such creations can arouse aesthetic experiences can only be fully understood in neural terms'.[668]

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664 Zahorodna, *Neuroestetyka*…, p. 153.

665 Science has not yet fully explained what the emotionality of music consists in, nor has it – as of yet – been able to create a dictionary of musical structures corresponding to specific emotions. That notwithstanding, there are qualities among the means of musical expression that allow emotions to be communicated in a universal way.

666 Włodzisław Duch, *Neuroestetyka i ewolucyjne podstawy przeżyć estetycznych [Neuroaesthetics and the Evolutionary Basis of Aesthetic Experiences]* (e-publication) (Toruń: Uniwersytet Mikołaja Kopernika, [s.a.]), p. 1, http://www.fizyka. umk.pl/publications/kmk/07-Neuroaesthetics.pdf.

667 Vilayanur S. Ramachandran and William Hirstein, quoted in: Piotr Markiewicz, Piotr Przybysz, Rozdział IV *Neuroestetyczne aspekty komunikacji wizualnej i wyobraźni [Chapter IV. The Neuroaesthetic Aspects of Visual Communication and Imagination]* [in:] *Obrazy w umyśle. Studia nad percepcją i wyobraźnią [Images in Mind. Studies on Perception and Imagination]*, ed. Piotr Francuz (Warszawa: Wydawnictwo Naukowe Scholar, 2007), p. 114.

668 Semir Zeki, quoted in: Zahorodna, *Neuroestetyka*…, p. 155. McLuhan was also of the persuasion that 'the serious artist is the only person able to encounter technology with impunity, just because he is an expert aware of the changes in the sense perception'. See: McLuhan, *Wybór tekstów*…, p. 225.

An attempt to formulate universal, fundamental laws of aesthetic experience was made by Vilayanur S. Ramachandran.[669] However, these laws did not take into account all the aspects that are important in the reception of a work, e.g. its originality, hence some recent attempts to go beyond the neuro-aesthetic paradigm. Representatives of enactivism – an interdisciplinary research platform considered as an alternative to cognitivism – put forward the thesis of 'embodied cognition' and 'distributed cognition', saying that it is not just the brain or the nervous system, but also other systems of the human body, that are involved in cognitive processes.[670] An important criterion here is the equation of cognition with action – thinking employs inference based on motor patterns, as well as many metaphorical structures.[671] This, in turn, leads to the conclusion that music is linked to emotion through movement.[672] While listening to music – not just during a concert – all acoustic events are analysed both from an auditory and a visual perspective at the same time. Even if the performers remain invisible, the viewer guesses what movements and gestures they are using during the process of creating the sound.

According to Arnie Cox, the principle of *mimesis* is an integral part of musical experience: the listener imagines the source of a sound by tracking its envelope and timbre, most commonly through the

669 Amongst these, he singles out the following: highlighting elements and their differences; abstracting the salient features of objects; perceptual grouping and background separation, enabling the segmentation of objects and abstract similarity relations; contrasting; isolating visual modules (shape, colour) in order to focus attention; non-obvious groupings that challenge perception, whose resolution provides pleasure for the mind and increases curiosity; synchronisation of processes in both hemispheres of the brain leading to stronger stimulation; avoiding accidental contour coincidence and unnatural perspective, as well as generalising the point of view; rhythmising and ordering; metaphorising as a basic cognitive mechanism, offering the possibility to organise and encode information about the world more effectively. See: Vilayanur S. Ramachandran, *Lecture 3: The Artful Brain*, http://www.bbc.co.uk/radio4/ reith2003/lecture3.shtml.

670 Francisco J. Varela et al., *The Embodied Mind: Cognitive Science and Human Experience* (Cambridge: MIT Press, 1991).

671 See: George Lakoff, Mark Johnson, *Philosophy in the Flesh. The Embodied Mind and its Challenge to Western Thought* (New York: Basic Books, 1999).

672 Indeed, there is a close relationship between motion and emotion. Already Eduard Hanslick defined music as 'sonorous forms in motion' in which extra-musical meanings may be reflected precisely through movement, See E. Hanslick, *O pięknie w muzyce: studjum estetyczne [On Beauty in Music: an Aesthetic Study],* translated by Stanisław Niewiadomski (Warszawa: M. Arct, 1903).

metaphor of shape.[673] Drawing on research by cognitive scientists, Cox called this phenomenon the 'mimetic hypothesis'.[674] This process is explained similarly by Rolf Inge Godøy, who claims that music is indirectly perceived through other senses, which support the interpretation and orientation of the incoming acoustic signals.[675] Godøy, however, draws attention to the role of imagining the activity, not the object. Through experience and learning, motoric programs are formed and stored in the brain.[676] These mappings are coupled with 'embodied experience'. By attentively listening to music, the mind, in a certain sense, virtually imitates the process of sound creation. According to Godøy, musical perception is therefore not merely a representation, but also a simulation[677] during which the listener thinks of sounds and music in terms of movement, acting as an emotive and aesthetic image. Piotr Podlipniak is of a similar persuasion: 'musical cognitive representations do not have a conceptual structure, but primarily reflect gestural figures chiefly associated with the pre-conceptual level'.[678] There is, after all, evidence that the two spheres – movement and sound – have always been closely linked, as music is, just like gesture, most likely a pre-linguistic human ability[679] and therefore a universal form of expression.

Wodzisław Duch emphasises that art must not be reduced to psychophysiological brain stimulation alone.[680] Neuroaesthetics will, therefore, not replace traditional theories of aesthetics (despite the initial assertions by the pioneers of the field mentioned above, Zeki and Ramachandran), but may instead provide answers to questions that traditional historically and philosophically oriented analyses have not been able to answer clearly.

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673 Arnie Cox, *The Mimetic Hypothesis and Embodied Musical Meaning*, *Musicae Scientiae*, 2001, Vol. 5, issue 2, pp. 195–212.

674 Cox, *The Mimetic Hypothesis...*

675 Rolf Inge Godøy, *Motor-Mimetic Music Cognition*, Leonardo, 2003, Vol. 36, issue 4, pp. 317–319.

676 For example, when the trumpet's sound is more associated with the image of vigorous blowing than with a mouthpiece, valves, tubes, or metal. In the case of drum playing, the mental image is not that of the vibrating membrane, but of the movements and gestures of striking.

677 Godøy, *Motor-Mimetic Music Cognition…*

678 Piotr Podlipniak, *Uniwersalia muzyczne [Musical Universalia]* (Poznań: Wydawnictwo Poznańskiego Towarzystwa Przyjaciół Nauk, 2007), p. 54.

679 Podlipniak, *Uniwersalia muzyczne…*, p. 77, 106.

680 Duch, *Neuroestetyka…*, p. 1.

2.4.4. Sensory (r)evolution – new perceptual skills

At its inception, the Western European civilisation, built for several millennia, was primarily based on the paradigm of audibility. This has been noted by Wolfgang Welsch, who added that it was not until the fifth century BC that the primacy of vision in the fields of philosophy, science, or arts began: 'with Plato, the visual model had already triumphed entirely'.[681] In accordance with the adage *verba volant, scripta manent*, the spread of writing and the culture of the written, 'visible' word continued to form slowly, but steadily. This evolution was accelerated by the invention of print: 'as the Gutenberg typography filled the world, the human voice closed down. People began to read silently and passively as consumers.'[682] In the middle of the 20th century, social communication and culture were dominated by audiovisuality, which upended the long-standing status of the written word as one of the most important media.[683] The audiovisual message became 'the basis for orientation in the environment of the participants of the present, as well as the dominant mode of cultural articulation'.[684] The development of film, television, the Internet, and other media meant that 'dynamic images' started appearing in everyone's daily life ever more often, gradually transforming their consciousness.[685] Józef Robakowski, a pioneer of Polish video art, wrote defiantly:

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681 Wolfgang Welsch, *Na drodze do kultury słyszenia? [Towards a Culture of Listening?]*, translated by Krystyna Wilkoszewska [in:] *Przemoc ikoniczna czy „Nowa widzialność"? [Iconic Violence or 'New Visibility?']*, ed. Eugeniusz Wilk (Katowice: Wydawnictwo Uniwersytetu Śląskiego, 2001), p. 59.

682 Marshall McLuhan, *Galaktyka Gutenberga [The Gutenberg Galaxy]* [in:] McLuhan, *Wybór pism [Selected Writings]*, translated by Karol Jakubowicz, Warszawa: Wydawnictwa Artystyczne i Filmowe (1975), p. 262.

683 Martin Jay points out that it was only at the end of the 19th century, amid the cult of Richard Wagner initiated by Baudelaire, that the peculiar apotheosis of sound and depreciation of sight manifested. Jay recalls that Bergson's critique of ocularcentrism (visually constituted subjectivity) had a strong influence on subsequent decades. As it turns out, even in the field of neuropsychology. See: Martin Jay, *Kryzys tradycyjnej władzy wzroku. Od impresjonistów do Bergsona [The Crisis of the Ancien Scopic Regime: From the Impressionists to Bergson]*, translated by Jarosław Przeźmiński [in:] *Odkrywanie modernizmu. Przekłady i komentarze [Discovering Modernism. Translations and Commentaries]*, ed. Ryszard Nycz (Kraków: Universitas, 2004), pp. 295–330.

684 Maryla Hopfinger, *Kultura współczesna – audiowizualność [Contemporary Culture – Audiovisuality]* (Warszawa: Państwowy Instytut Wydawniczy, 1985), p. 58.

685 Stanisław Piskor, *Wizualizacja – konwencja – postawa [Visualization – Convention – Attitude]* [in:] *Dwudziestowieczna ikonosfera w literaturach europejskich. Wizualizacja w literaturze [The Twentieth-Century Iconosphere in European Literatures. Visualisation in Literature]*, ed. Bożena Tokarz (Katowice: Wydawnictwo Naukowe „Śląsk", 2002), p. 18.

> Employing my knowledge of physical reality, analysing it with the aid of modern technology (film, photography, video, sound...), I wish to compromise my own perceptual habits. (...) Being aware that imagination, intuition, and the means of marking currently in use are imperfect, I resort to the methods adopted in science and to the development of technology.[686]

Under the influence of new media creations, the mindset and imagination of the modern viewer and listener have changed. As diagnosed by Maryla Hopfinger, the culture of the latter half of the 20th century imposed and shaped the audiovisual experience of the world and forced the mind to develop a new kind of perception, integrating verbal and non-verbal, auditory and visual behaviours.[687] The new semiotic objects are increasingly distinguished by their 'substantive syncretism'[688] and 'high degree of iconicity',[689] thus fostering the development of an integral receptive mechanism that Hopfinger calls the *audio-visual syndrome*. As late as the beginning of the twentieth century, 'it seemed that this transformation, just as fundamental as it was extensive, would require time to harden. Meanwhile, the subsequent changes happened quickly, as at their heart lay the expansion of electronics.'[690] Culture intersected with the technological sphere ever more often, and the situation of art in the late 20th century favoured a holistic reception – 'audiovisual wholes'. This was because multimedia allow the complex consolidation of materially diverse elements of behavioural and communication settings.[691] The reception mechanisms have privileged the audiovisual cultural experience over the verbal – contemporary cultural participants are oriented towards the fusion of auditory and visual information into a single meaningful

686 Robakowski, *Stan świadomości [State of Consciousness]* [in:] *Józef Robakowski – Stan świadomości [State of Consciousness]*, exhibition catalogue, Łódź: BWA, 1977.

687 Maryla Hopfinger, *Doświadczenia audiowizualne: o mediach w kulturze współczesnej [Audiovisual Experiences: On Media in Contemporary Culture]* (Warszawa: Sic!, 2003), pp. 32–33.

688 Hopfinger, *Kultura…*, p. 130.

689 Hopfinger, *Kultura…*, p. 134.

690 Hopfinger, *Doświadczenia…*, pp. 24–25.

691 Audiovisual communication is currently the subject of research in many academic fields – it is also a field of study.

whole.[692] Audiovisual and multimedia messages make us accustomed to perceiving the world in a way different to that perpetuated by the culture of print. Language ceases to be the matrix that organises the construction of our images of the world; in that role, it is supplanted by moving, vibrant, ambiguous, multilevel 'image-worlds'.

Konrad Chmielecki, a researcher of the phenomenon of intermediality, believes that the essence of new art 'is not the combination of multiple means of artistic expression into a polymedial message, but, rather, the artist's transgression of the existing divisions and the constitution of messages in a new 'in-between' space.[693]

These new means of artistic expression change perceptual habits and sometimes even force one into new mechanisms and different states of consciousness. With the development of audiovisual and tactile technologies, ever present in everyday life and in the arts, perceptions are changing. The evolution of culture confidently entered the digital media phase, owing to which perception is enriched by a new, peculiar 'inter-sense' – the '*multimedia sensitivity*'.[694]

Maurice Merleau-Ponty, in describing the process of perception from a phenomenological perspective, treats multisensory perception as 'a single, non-localizable cognitive process, a soul indivisible into parts'.[695] He further states that directed, conscious sensory experience is fleeting and alien to natural perception, which we carry out with our entire body simultaneously and which opens up to the inter-sensory

692 Elżbieta Aranowska et al., *Wpływ koloru otoczenia i stanu emocjonalnego słuchaczy na percepcję muzyki [The Influence of Ambient Colour and Emotional State of Listeners on Music Perception]* [in:] *Kształtowanie i percepcja sekwencji dźwięków muzycznych*…, p. 245.

693 Chmielecki, *Estetyka intermedialności*…, p. 11.

694 Porczak (ed.), *Wrażliwość multimedialna*...; a series of exhibitions mainly oriented towards the use of multimedia was initiated in the 1990s. It turned out that organising this type of presentation changed the way the artists themselves approached and thought of art: 'We registered the emergence of new aesthetics, their sensitivity and interests. It was them who made us realise that "those shaped by electronic media" perceive reality in a particular kind of way and are less interested in treating art instrumentally.' Porczak (ed.), *Wrażliwość multimedialna*...

695 Merleau-Ponty, *Fenomenologia percepcji*…, p. 233.

world.[696] Like the experience of a sensory quality, 'the experience of separated "senses" is possible only under a very special attitude.'[697] The body, on the other hand, according to Merleau-Ponty:

> [Is] a system in which each sense functions as a relay for the others; each sense is capable of translating and interpreting the data of the others without the intervention of a conceptual apparatus. (...) My body is the seat or rather the very actuality of the phenomenon of expression, and there the visual and auditory experiences, for example, are pregnant one with the other, and their expressive value is the ground of the antepredicative unity of the perceived world.[698]

The individual senses, and even the body as a whole, are therefore actively coupled to one another.[699]

New media art builds on the sensual, hence the artists' interest in the body as a tool and a material alike. The ontological question of 'what is a work of art?' has been reformulated as 'how does one feel it?'.[700] As part of this return to sensuality, Arnold Berleant criticises the distinction between the sensual (sensuous) – intellectual pleasure, mainly associated with the senses of distance – and the sensual (sensual), involving bodily pleasures. The body 'soaks up' inter-sensory

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696 Also, speaking from a purely biological point of view, the organ of hearing is not the only channel for receiving sound. In humans, there is an individualised mechanism of hearing with one's bones and the body. Importantly, the organism – as a whole – hears on a frequency scale wider than that utilised by the ear alone, sensing changes in the 'polarity and piezoelectric strain of organic piezoelectrics following the same rhythmic pattern as the acoustic wave'. See: Adam Adamski, *Percepcja muzyki, jej wymiar w sztuce i psychologii kwantowej [The Perception of Music, Its Significance in Art and Quantum Psychology]* (Bielsko-Biała: Compal, 2008), p. 103.

697 Merleau-Ponty, *Fenomenologia percepcji*…, p. 233.

698 Merleau-Ponty, *Fenomenologia percepcji*…, p. 256.

699 Following this line of thought, Richard Merrick attempted to prove that archetypal models of sound waves may be found in everything that shapes organic life, and that the universals of hearing are reflections of an overarching 'order of the universe'. In his theory of 'harmonic interference', he proves that everything related to the musical perception of sound, consonance, and tonality, but also the structure of the ear, head, bones, body, continents, galaxies, etc., is related to the physically quantifiable and visualisable regularity of the harmonic standing wave. See: R. Merrick, *Interference. A Grand Scientific Musical Theory*, http://www.interferencetheory.com/ index.html.

700 Monika Jadzińska, *Nowy model odbioru dzieła sztuki [A New Model for the Reception of a Work of Art]* [in:] Jadzińska, *'Duże dzieło sztuki'*…, p. 99.

experiences, and this is how it remembers the world. In memory, no pure images, pure sounds, or pure tactile sensations remain, but, rather, inter-sensory phenomena.[701]

As a result of the criticism of the symbolist approach to the analysis of thought processes that characterises cognitivist and constructivist approaches, a connectionist theory emerged, positing that information processing processes are concurrent in nature. The human being possesses a complex perceptual system in which no single receptor operates independently. Consciousness collects and fuses sensory signals into a single sensory experience[702] – into an integral, 'holistic effect'.[703] Each modality carries different information on the environment, but all senses react to the same object or event simultaneously, thus enriching the overall experience;[704] 'the hybridisation of media unleashes new great powers'.[705]

Włodzimierz Borowski, one of Poland's most important performance and installation creator, described his artistic activities as follows:

> Initially, I would synthesise a kind of consciousness of pure abstraction: straddling the line between music and plastic experience. For the domain of the visual arts, I sought a form of recording visual experience, a method of notation akin to that of musical notation. The art object would therefore be a kind of score-trace that serves to reveal something else. (...) The object-image exists, but at the moment of its perception it reveals another dimension, opens up a space, creates a breach, an opening through which we enter somewhere else.[706]

Temporal and spatial relationships play an important role for the multisensory ability to perceive objects and events. Listening to music, or at least imagining it, engages the motor areas of the brain, and

701 Arnold Berleant, *The Sensuous and the Sensual in Aesthetics*, *Journal of Aesthetics and Art Criticism* (1964), Vol. 23, issue 2, pp. 185–192.

702 See: António Rosa Damásio, *Tajemnica świadomości [The Feeling of What Happens: Body and Emotion in the Making of Consciousness*] (Poznań: Rebis, 2000).

703 Wang Jisheng, *An Introduction to Aesthetic Perception. On the Structure and Function of Aesthetic Perception*, translated into English by Yu Chenwei (Shanghai: Shanghai Scientific and Technological Literature Publishing House, 2008), p. 36.

704 Paul Bertelson, Beatrice De Gelder, *The Psychology of Multimodal Perception* [in:] *Crossmodal Space and Crossmodal Attention*, eds. Charles Spence, Jon Driver (Oxford: Oxford University Press, 2004), pp. 141–177.

705 McLuhan, *Zrozumieć media...*, p. 92.

706 Bury, *Kreowanie pustki – rozmowa z Włodzimierzem Borowskim*…, p. 45.

the synergistic effect – the coupling of individual movement commands – influences one's perception of entire sequences.[707] Thus, listening to music is naturally combined with, for instance, tapping one's foot, nodding one's head, and, in a more sophisticated way, dancing. Research shows that one's intermodal abilities are innate, but furthermore change and shape themselves with age. These changes go hand in hand with the integration and separation of the respective senses, i.e. people learn both to perceive ('grasp') the entire multimedia message and to focus on a single modality.[708]

— **The perfect interfaces – the computer, the monitor and multimedia**

The generations shaped by electronic media are characterised by a particular perception of reality through the prism of these media. 'We are a society of information, screens, and monitors'[709] – writes Lev Manovich. Piotr Zawojski and Andrzej Gwóźdź also refer to the twentieth century as the 'age of screens', claiming that the ubiquity of monitors constitutes a decisive contribution to the dominant style of culture.[710] The cinema screen, and in more recent decades, the interactive monitor, have blurred the line between simulation and reality. Whereas cinema, in the course of its development, sought to integrate diverse elements into a meaningful and aesthetic whole, the computer allows one to make use of a variety of modes of social communication – auditory, visual, verbal, non-verbal, audiovisual; the computer repeats and collects all previous communication experiences and adds new ones: interactivity, simulation and virtualisation.[711]

Tomasz Misiak notes that 'the effects of technology take place not only in the theoretical sphere of concepts, but above all they constantly and inevitably change the proportions of our senses (...)

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707 Vickhoff, *A Perspective Theory…*, pp. 52–53.

708 David J. Lewkowicz, *The Development of Temporal and Spatial Intermodal Perception* [in:] *Cognitive Contributions to the Perception of Spatial and Temporal Events*, ed. Gisa Aschersleben, Talis Bachman, Jochen Müsseler (Amsterdam et al., Elsevier: 1999), pp. 397–407.

709 Lev Manovich, *The Language of New Media* (Cambridge: MIT Press, 2001), pp. 77, 99, 114.

710 Andrzej Gwóźdź, *Mała ekranologia [A Little Screenology]* [in:] *Wiek ekranów [The Screen Age]*, eds. Piotr Zawojski and Andrzej Gwóźdź (Kraków: Rabid, 2002), p. 15.

711 Kimberly Ann Foley, *Perception, Aesthetics, and Culture in New Media*, Massachusetts Institute of Technology (1988), http://mf.media.mit.edu/pubs/thesis/foleyMS.pdf.

dehierarchising, reorganising our perception'.[712] The technological reality has become a sphere that shapes everyday sensibilities and creates new models for participation in the world. The development of ever newer electronic interfaces has brought about changes to perceptions and personalities, especially the youth of the younger generation. This generation has become the 'screen generation', one made up of those 'born with a mouse in their hand',[713] for whom the new media are the natural environment for maturation and existence alike.

In describing the differences between oral and written culture, Walter J. Ong emphasised that human thought requires a certain kind of continuity – hence the establishment of its lines in speech and text.[714] In the consciousness of primitive societies belonging to the audial (auditory) order, it was not the eyes that were the most important sensory organ, but, rather, the ears, which received all omnidirectional sound stimuli at the same time.[715] At the beginning of the 21st century, another perceptual breakthrough in human history is taking place. Media, such as the computer and the Internet, are taking people out of linear time. As Mirosław Filiciak writes:

> Moreover, the distinction between what has already happened, is happening at a given moment and will happen a moment later is problematic in a modern world governed by a fragmented database logic – time is 'timeless', neither linear nor cyclical. Broken into multiple, parallel streams that one may switch between.[716]

712 Misiak, *Od przestrzeni akustycznej do akustycznej cyberprzestrzeni. Słyszenie w refleksji filozoficznej a muzyka elektroniczna [From Acoustic Space to Acoustic Cyberspace. Hearing in Philosophical Reflection and Electronic Music]*, Ogólnopolska Konferencja Muzykologiczna 'Muzyka jako medium komunikacji' [National Musicological Conference 'Music as a Medium of Communication'], Poznań 2007.

713 Szpunar, *Urodzeni z myszką w ręku…*, p. 261.

714 Ong, *Psychodynamika oralności [Psychodynamics of Orality]* [in:] *Antropologia słowa. Zagadnienia i wybór tekstów [Anthropology of the Word. Issues and a Selection of Texts]*, eds. Grzegorz Godlewski et al. (Warszawa: Wydawnictwa Uniwersytetu Warszawskiego, 2003), p. 196.

715 As late as the 20th century, when attempts were made to play instructional films shot in Europe to certain African tribes, the viewers were unable to string the sequence of images together into a concrete narrative; for them, no hierarchy of planes existed, and they paid attention to peripheral content, such as an animal running in the background.

716 Mirosław Filiciak, *Media i czas – czyli o tym, że nie tylko przyszłość nie jest tym, czym była [Media and Time – or the Future is Not What It Used to Be]*, lecture accompanying the exhibition *Przyszłość nie jest tym, czym była [The Future is Not What It Used to Be]*, 2 December 2010, Kino/ Audytorium, http://www.csw.art.pl/index.php?action=aktualnosci&s2=1&id=319&lang= (access: 21 July 2014).

He rightly observes that the new media are thus changing people's feeling of space-time:

> Time not only changes in quality, but also multiplies itself: tools such as mobile phones, high-speed connections, and software that encourages working in multiple windows make it possible to do several things at once and to process reality multichannel (which will be called cultural ADHD, attention deficit by some, its multiplication by others), (...) paradoxically, the acceleration of experience and the expansion of the present at the expense of the future and the past results in specifically nostalgic forms of imagery and structures of feeling.[717]

Ewa Trębacz also believes that the nature of our perception is changing, evolving towards a simultaneity of experience and distraction: 'This simultaneous, multilevel, intermedial and multidimensional, yet "short-distance" way of seeing the world, new in its universality, has and will continue to have fundamental consequences for the further development of art.'[718] On the other hand, the composer warns us, overloading one's senses puts perception in a state of 'overload' and 'overstimulation'. Since simultaneity and multilevelness have become the norm, then focusing on a chosen topic for a longer time presents an ever greater difficulty.

'In a culture dominated by the visual, there arises a concomitant loss of trust in what is seen',[719] notes Wolfgang Welsch. He recalls the words of one of the greatest thinkers of the 20th century, Martin Heidegger, who called the turn of ancient cultures from the auditory to the visual 'the original sin of Western philosophy'.[720] The rejection of the prevalent visual model of modernity – and thus, of the power of sight by the culture of the late 20th century – activates the other

717 Filiciak et al., *Młodzi i media. Nowe media a uczestnictwo w kulturze. Raport Centrum Badań nad Kulturą Popularną SWPS [New Media and Participation in Culture. Report by the SWPS Centre for Popular Culture Research]* (Warszawa: Szkoła Wyższa Psychologii Społecznej, 2010), p. 15, http://bi.gazeta.pl/im/9/7651/m7651709.pdf.

718 Ewa Trębacz, *Pełna imersja: rzeczywistość czy utopia? Technologie przestrzenne z punktu widzenia artysty*, *[Full Immersion: Reality or Utopia? Spatial Technologies from the Artist's Point of View]*, *Glissando*, 2010, issue 16.

719 Welsch, *Na drodze do kultury słyszenia…*, p. 62.

720 Source of the quote: Welsch, *Na drodze do kultury słyszenia…*, p. 63.

senses.[721] As early as the 1960s, Marshall McLuhan wrote that 'the visual culture of the West (...) is now giving way to an age where auditory and tactile senses regain importance'.[722]

— **Sensory immersion**

Immersion is a perceptual phenomenon related to virtual reality – visual, auditory, tactile, or multimodal – best achieved in communication that affects all the senses simultaneously. The immersion of the interactor in an artificially generated world consumes their perceptual abilities by abolishing the boundaries between the media (speakers, screens) and the viewer. In a general sense, immersion is a phenomenon similar to the perception of architecture, and a new experience of one's own body becoming an integral part of an imposed reality, the cyberspace.[723] This is due to the fact that the participant in the multisensory event – the 'immersant'[724] – perceives it not as artificial, but as real. Moreover, the virtual environment is not just about illusion, but about transcending it, a sense of 'being' within. Subjective consciousness then merges with the artwork, creating a new, powerful experience transmitted and perceived with all the senses and the entire body. Even McLuhan believed that 'the aspiration of our time for wholeness, empathy and extended depth of awareness is a natural adjunct of electric technology'.[725]

A tool that permits the integration of all communication modalities is the computer. This hypermedium adds a new dimension to the phenomenon of immersion, enriching it with 'multi-channel signal streams, responsiveness, and telepresence and its various variations provided by ever-improving technology'.[726] New media gain the power to break down perception from a distance and, through them, the

721 Martin Jay, *Nowoczesne władze wzroku [Scopic Regimes of Modernity]*, translated by Marek Kwiek [in:] *Przestrzeń, filozofia i architektura. Osiem rozmów o poznawaniu, produkowaniu i konsumowaniu przestrzeni [Space, Philosophy, and Architecture. Eight Conversations on Cognition, Production and Consumption of Space]*, ed. Ewa Rewers (Poznań: Wydawnictwo Fundacji Humaniora, 1999), p. 79.

722 McLuhan, *Zrozumieć media...*, p. 16.

723 Mariusz Pisarski, *Cyberprzestrzeń – zjawisko immersji [Cyberspace – the Phenomenon of Immersion]*, http://www.techsty.art.pl/hipertekst/cyberprzestrzen/immersja.htm.

724 Zawojski, *Wewnątrz obrazów...*

725 McLuhan, *Zrozumieć media...*, p. 35.

726 Pisarski, *Cyberprzestrzeń…*

senses become, in a certain sense, relocated or extended. Immersion at a distance – teleimmersion – is, after all, a simulation (illusion) of presence, a 'sensory teleportation' of sorts.

In the arts, means leading to immersion have been in use for several decades. In music, this issue has been present since the advent of phonography, and became permanently associated with electroacoustic and interactive music, giving rise to new genres of art: multimedia-interactive installations and performances. The development of musical sound systems has also been striving for audial immersion since its inception – hence the evolution from stereophony, quadrophonics, surround systems, octophony to acousmatics in the broadest sense of the word. Such systems are built in concert halls, art galleries, and museums.[727] Owing to them, instead of concentrating on a selected sound event and its movement, the artist is able to project the space as a whole – a microcosm of interrelationships. The immersive musical work becomes a sound installation where the acoustic space becomes the main form-creating factor.[728]

New tools, new possibilities, and new human perceptions have caused artists to pay more attention to something that has always been beyond the reach of full control – something that one might call the periphery or margins of performance. The quest for immersion is, at the same time, a desire to master these areas, to enable the possibility of a stronger, multifaceted participation in art.

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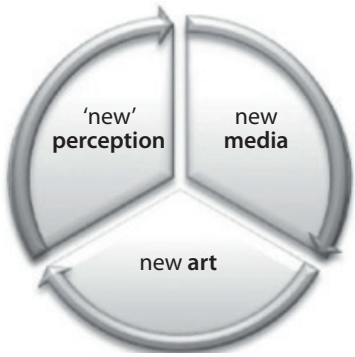
Art theory never kept up with practice. As civilizational and cultural evolution accelerated in the 20th century, humanity stopped keeping up with it, too – the avant-garde ideas of artists proved too demanding for the senses, perception and taste of the average, incompetent viewer. At the dawn of the new millennium, however, it would appear that the last hundred years have forced human perception to adapt – at least partially – to new communicative, cultural and social situations, as well as to new phenomena in art.[729] These changes were further accelerated and deepened by the rapid expansion of electronics. A new paradigm of closely and multidimensionally coupled forces has emerged:

727 Fatima-Zahra Kaghat et al., *Experimenting with Sound Immersion in an Arts and Crafts Museum*, CEDRIC/CNAM, Paris, http://cedric.cnam.fr/PUBLIS/RC1811.pdf.

728 Kaghat et al., *Experimenting with Sound Immersion...*

729 Installation art was therefore a response to the need to extend the boundaries of aesthetic perception. Jadzińska, *Nowy model odbioru dzieła sztuki*…, p. 129.



Example 32. A diagram of the looping influence of new media on art and perceptual skills

When it comes to the theory – of musicology and aesthetics – this situation poses quite a problem. The traditional analytical and interpretative tools employed thus far have proved inadequate for research into new media art, failing to capture the specificity of this subject matter. How does one find a solution here? Inspired by Kurtz Gödel's theories of modern mathematics and Ludwig von Bertalanffy's system theory, Roman Berger, an eminent philosopher and composer, stated that if a paradigm-system shows dysfunctions, one should 'jump from it to the level of a system of a higher-order',[730] and that 'the phenomenon of music, considered in terms of its place in the world – in the holomovement – suggests to us that it is high time to (...) reintegrate the current *disiecta membra* – analysis, music theory, psychology, communication theory, semiotics – into a single system'.[731] According to this principle, therefore, when examining an electroacoustic or multimedia artwork, it would be appropriate to refer not just to the analytical models of the respective disciplines, but to certain psychological-perceptual universals. After all, discoveries in new branches of science, such as the psychology of perception, are just as groundbreaking as the spread of new media, which have put this perception to the test. Although the outline of the theories presented in this chapter has not yet given rise to proven, practical analytical methods, it does provide a methodological background, opening up to new interpretative challenges posed by electroacoustic and multimedia art of the 21st century.

730 Roman Berger, *Zasada twórczości. Wybór pism z lat 1984–2005 [The Principle of Creativity. A Selection of Writings from 1984–2005]* (Katowice: Akademia Muzyczna im. Karola Szymanowskiego w Katowicach, 2005), p. 335.

731 Berger, *Zasada twórczości…*, p. 340.

PART THREE

New media in Polish electroacoustic art

3.1. Algorithmisation, the computer and surconventionalism in the electroacoustic works of Stanisław Krupowicz

Notwithstanding the fact that his date of birth (1952) is close to the composers of Stalowa Wola's Generation '51 with their New Romantic orientation style- and aesthetic-wise, Stanisław Krupowicz remains an artist independent of his peers – he has exceptionally individual views[732] and working methods. This is partly due to his interests and education, which are quite unusual for a composer: between 1971 and 1976, he studied at the Faculty of Mathematics and Mechanics at the University of Warsaw, then studied composition at the *State* Higher School of Music in Warsaw under Włodzimierz Kotoński and Tadeusz Baird (1975–1981). Several years spent studying at the Center for Computer Research in Music and Acoustics (CCRMA) at California's Stanford University turned out to be a breakthrough period in the composer's life. Owing to the knowledge he acquired during his mathematical studies, as well as the access to the latest technologies, which one could hardly expect to see in Poland, Krupowicz was able to bring his innovative ideas to life. From 1983 to 1984 – as a Fulbright Foundation scholar – he studied computer composition at Stanford under John Chowning and Leland Smith. There, he worked as an assistant, and, in 1986 won the Prix de Paris – a scholarship for the creation of a work at IRCAM in Paris. In 1989, with the support of the Barbara Piasecka-Johnson Foundation, he carried out acoustic research dedicated to the Stradivarius violin.[733]

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732 The composer himself is very reluctant to write about his life. And if he does, he does so with his trademark humour and undisguised irony: 'I don't feel like writing those damn biographies anymore. They're nothing but trouble. First, you have to come up with one. Second, write it. Third, register it with ZAiKS, because it might happen that some greenhorn scribbler reprints it in his newspaper. It would then be necessary to sue for copyright infringement and/or to take part in an unwanted polemic in more or less widely read papers, to demonstrate the lies and misrepresentations, to be benevolently malicious. (…) There is little pleasure in writing biographies; no one even wants to pay the right money'. Stanisław Krupowicz, commentary on the piece *Partita* [in:] *Warszawska Jesień '02. 45. Międzynarodowy Festiwal Muzyki Współczesnej, 20–28 września 2002 [Warsaw Autumn '02. 45th International Festival of Contemporary Music, 20–28 September 2002]*, [programme book], p. 112.

733 The product of this research – carried out under the inspiration of and in collaboration with Bogdan Skalmierski – is a scientific paper describing the structure of and stress distribution in the resonance box of a Stradivarius violin – to be exact, in the specimen named Messiah. The mathematical

Numerous trips and scholarship projects in the 1980s allowed Krupowicz to gather experience that, upon his return to Poland, made him one of the most pivotal creators of electroacoustic music in the country.[734] Currently, he teaches composition and computer music at the Academy of Music in Wrocław; he is also a co-founder of the Academy's Computer Composition Studio, in operation since 1998, of which he remained the head ever since.[735] Many consider the studio to be Poland's most important centre for electroacoustic music.

Most of the electroacoustic compositions by Krupowicz were produced in the latter half of the 1980s and in the early 1990s. The years between 1995 and 2002 were a blank period for him, as they did not see the creation of a single work employing electronic works – only improvised performances produced with Ryszard Piegza. Beginning with *Partita* (2002), he seemed to have taken a redoubled interest in electroacoustics – most of his works created in recent years make use of computer media.

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description allowed Skalmierski to patent the idea for constructing a similar violin, sounding like the legendary Stradivarius specimens. See: http://www.forumakad.pl/archiwum/2002/03/artykuly/26-sposob_bycia.htm (access: 21 July 2014).

734 He conducted PTMW courses in Kazimierz, and was a member of the repertoire committee of the 'Warsaw Autumn' Festival between 1993 and 1996, then co-founder and president of the Friends of the 'Warsaw Autumn' Foundation between 1998 and 2000. He was a laureate of many competitions: in 1981, he won the 2nd prize of the Young Composers' Competition of the Polish Composers' Union for *Tempo 72* for amplified harpsichord and strings (1981), in 1985, the 2nd prize at the NEWCOMP International Computer Music Competition in Boston for *Thus Spake Bosch* for tape (1985), and in 1987, a distinction at the 8th International Irino Competition in Tokyo for *Farewell Variations on a Theme by Mozart* for amplified string quartet and tape (1986). He received the A. Borodin Foundation Prize twice – in 1989, for *Only Beatrice* for amplified string quartet and tape (1988), again in 1990, for *Thus Spake Bosch*. In 1994, he was awarded the Third Prize at the UNESCO International Rostrum of Composers in Paris for his work *Fin de siècle* for orchestra (1993).

735 In 2005, on the initiative of Krupowicz and the Wrocław composer community associated with electroacoustic music, the International Festival 'Musica Electronica Nova' (initially as an extension of the 'Musica Polonica Nova' Festival) was established. Currently, the festival is organised by the Wrocław branch of the Polish Composers' Union (ZKP) in cooperation with the Academy of Music in Wrocław, the local Philharmonic Orchestra, and Polish Radio. The first edition of the festival was already awarded the Wrocław Music Prize in the initiative category of the 2004/2005 season. Initially, the 'Musica Electronica Nova' was an author's festival with no programme committee, the programme being put together entirely by its artistic director, Stanisław Krupowicz.

3.1.1. Music and mathematics – algorithmic electronic music for tape

'In the hands of the creator, a computer equipped with the right software becomes a 'composers assistant' of sorts'[736] – writes Krupowicz, adding that he himself uses it primarily in the context of algorithmic music. This type (technique) of composition managed to dominate his work absolutely. Over time and with technological developments, his musical vocabulary evolved, invariably remaining highly individualised.

In Krupowicz's works, electronics – especially computers – are also used extensively in several pieces that do not distinguish any electronic media in their lineup.[737] One of the most important examples of this is the *ARDO 4031* wind quintet from 1979 – the first composition whose sound material was generated by computer.[738] Krupowicz returned to this working method in the *Farewell Variations on a Theme by Mozart* (1986) and *Partita* (2002).

One of the first works in which Krupowicz used electronic media was *Music for S* for tape, composed during his doctoral studies at Stanford.[739] Here, the creator used additive synthesis and a digital instrument simulating the human voice (primarily the sound of sung vowels), built by John Chowning.[740] Krupowicz used its algorithms, extending them to include the glissando effect, which became the form-shaping element of the piece. To Chowning's algorithm, Krupowicz mathematically added a module that interpolated between the emphasised frequency bands (formants), and it had a part in shaping the spectrum of the generated sound imitating the human voice. Given the mathematical complexity of the procedures, and,

736 Piotr Tutka, *Europa Stanisława Krupowicza [Europe by Stanisław Krupowicz]* [interview with the composer], *Estrada i Studio*, 2004, issue 12, http://www.eis.com.pl/virtual/modules.php?name=Sections&sop=viewarticle&artid=919.

737 Here, one could compare Krupowicz's work to the compositional technique of Iannis Xenakis, the creator of stochastic music.

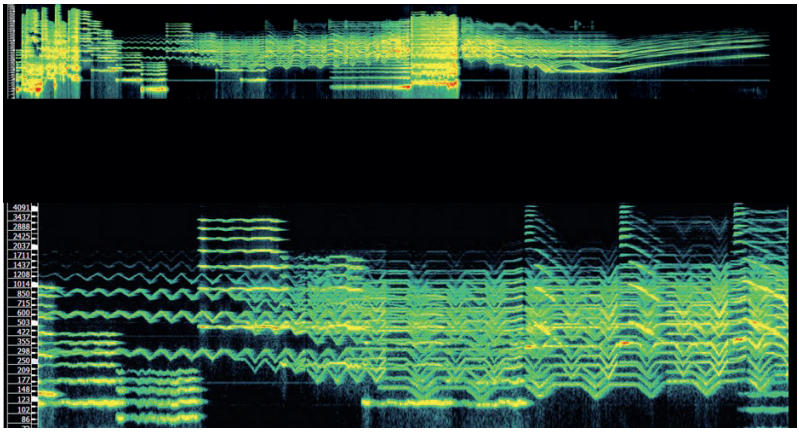
738 Kotoński, *Muzyka elektroniczna*…, p. 252.

739 With this piece, Krupowicz made his debut at the 'Warsaw Autumn' in 1984. Unfortunately, when documenting the festival performances, Polskie Nagrania recorded the piece backwards.

740 John M. Chowning was the supervisor of Krupowicz's doctoral thesis. As one of the most important discoverers in the history of electroacoustics, he is best known for his development of FM synthesis (cf. Chapter 2.2). He was also involved in composing. Owing to *Phoné* (1981), Chowning became the first composer to use FM algorithms to synthesise the human voice. These, in turn, were used by Krupowicz in several of his own works.

as a consequence, the need for sufficient computing power, additive synthesis is usually carried out by computer. While working on *Music for S*, Krupowicz was able to use Stanford's Samson Box computer,[741] which was ultra-fast for the time and boasted as many as 256 separate generators. Nevertheless, it took a very long time to synthesise the sound – generating a mere few seconds of a song would sometimes take several hours.

The sound bands generated by the computer system, intended to imitate the human voice, are superimposed over one another in the course of the piece, forming bundles of several voices. These, in turn, constitute electronic choirs of sorts, which, structured into diminished triads, glissando up and down at different speeds. Three such wandering bundles interpenetrate one another. The audible upward fifth leaps culminate with a descending glissando. This sequence repeats itself three times, then yields the spotlight to a section with a noisier sonic quality to it.



Example 33. Spectrogram of *Music for S* – the whole piece (above) and a passage with the glissandoing bundles (below)

As a whole, *Music for S* is constructed from timbre-identical bands, making the texture and form of the piece quite homogeneous. The bands, saturated with reverberation, are reminiscent of the sound of alarm sirens wailing in the distance. These wails may give one an impression of anxiety, even fear. This stands in line with the message of the piece. Its title, however, contains a dedication to the 'Solidarity' movement (camouflaged, due to censorship, under

741 See: https://ccrma.stanford.edu/~jos/kna/Experiences_Samson_Box.html.

the abbreviation 'S'), which – as it is worth recalling – was still operating underground in the early 1980s. In the commentary on the piece, he wrote that *Music for S* was the result of 'a persistent struggle with a soulless mechanism; it is an example of a bilateral agreement in which one of the parties (that is, myself) was forced to realise a necessity, which did not liberate it at all, contrary to what some well-known sages had once stated.[742] He concluded the thought with a hint of irony:

> Such agreements have become very popular of recent, as they save a lot of time previously wasted on unnecessary argumentation. This time is being used effectively in the endeavour of guiding humanity towards a great and bright future, which, it is redundant to say, is closer to us in 1984 than ever before.[743]

In 1985, at the same electroacoustic studio in Stanford, Krupowicz captured *Thus Spake Bosch* on tape.[744] The main idea of the piece was to build a musical form by operating with several expressive, texturally- and sonically- distinct sections. Most of them are distant echoes of music of the past – they use things like a tonal cadence and a two-voice, Baroque-like counterpoint. To the musically-trained ear, their provenance is clear, though no direct quotations or even pseudo-quotations are to be found here; if anything, one may find allusions of sorts. This is because Krupowicz, with the aid of computer algorithmisation, managed to construct patterns for improvisation in a given musical style. Unlike *Music for S*, the material here is heterogeneous, with each musical section executed using a different timbre. In addition to imitating the human voice, he imitates the sound of things like plucked string instruments (synthesised by David Jaffe) and bowed strings (synthesised by Bill Schottstaedt).

The piece begins with an introductory phase lasting several minutes, consisting of superimposed two planes of sound: a band of noise and quasi-percussive beats. Their volume levels rise smoothly. This phase is interrupted by a tritone interval, intoned with a timbre

742 Krupowicz, commentary on the piece *Music for S* [in:] *Warszawska Jesień '84. 27. Międzynarodowy Festiwal Muzyki Współczesnej, 21–30 września 1984 [Warsaw Autumn '84. 27th International Festival of Contemporary Music, 21–30 September 1984]*, [programme book], p. 219. Here, Krupowicz refers to words by Hegel ('Freedom is the recognition of necessity.') and Lenin ('Freedom is the insight into necessity').

743 Krupowicz, commentary on *Music for S…, p. 219*.

744 The piece was awarded the 2nd Prize at the NEWCOMP International Composers' Competition in Boston.

imitating an organ – this is the first section of the work's main phase. In contrast, the two-voice harpsichord counterpoint that follows is texturally reminiscent of invention. In one interview, Krupowicz explained how he achieved this effect:

> In *Thus Spake Bosch,* there is a Baroque-style harpsichord passage that the computer 'improvises' according to three rules (I was very surprised, by the way, that so little information is needed for the computer to produce such a convincing impression of the Baroque): the first is the tonal scheme (tonic-dominant-tonic); the second is the postulate of a two-voice texture that takes into account the registers and manual limitations of the harpsichordist; and the third is the use of several typical rhythm motifs. The counterpoint is, of course, entirely incorrect and full of errors, as it was concocted by a random number generator.[745]

For Krupowicz, the computer is in this case proving to be a better performer than a human being. Moreover, he finds it impossible to achieve a pastiche, and simultaneously a kind of unreal effect without making use of the possibilities of a computer:

> If I dictated these rules to people-improvisers, some would not play this at all. Those comfortable with baroque-style improvisation would have played according to all the rules of the period, too well – while the machine did as I programmed it, no more, no less. A musician would have invariably added or subtracted something. I am not talking about issues of very fast tempos or complex rhythmic pitches, in whose context the only flawless performer is the computer or disklavier (MIDI piano).[746]

Subsequent, less-than-half-minute-long sections bring in quite different timbres: strings, flute, guitar, and organ. In addition, each of the sections has its own, characteristic structure, depending on the pattern he set. Thus the string timbre usually performs rapid chord progressions, sometimes resembling cadential progressions, while the flute timbre weaves a cantilena-like melodic progression. The role of a turning point of sorts is played by the organ timbre, which always brings the co-sound of the tritone on *C♯–G* sounds. It is only at the end of the piece that a breakthrough and a 'resolution' to this dissonance appears – a pure, quintic quasi-chord (*C♯–G♯–D♯*) that resounds ever more quietly until the end of *Thus Spake Bosch*.

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745 Topolski, *Stanisław Krupowicz – interview*, *Glissando*, 2006, issue 9, p. 105.
746 Topolski, *Stanisław Krupowicz – interview…*, p. 105.

The successive sections of the piece interlock with one another and, owing to the use of quadrophony, move in space in a smooth and regular manner, as if they were drawing a circle.[747] The listener may be under the impression of being surrounded by various sound phenomena or observing from the centre a kind of carousel of textures and colours. The piece's overarching dramaturgy is created from its successive revolutions – a moving audiosphere that, in its complexity and variety, reminds one of the landscapes by Hieronymus Bosch, alluded to in the title. Fragments of Bosch's paintings may constitute separate wholes in their own right, as each has its own original symbolism. This prompts one to read the image as if it were a text, and brings to light its immanent storylines. Not unlike Bosch's canvases, Krupowicz's piece is made up of multiple, sometimes incompatible qualities – sound images. Thus, the inspiration drawn from the Renaissance visionary's painting resulted in creating a larger soundscape, a mosaic of colours, out of small pieces of music spread over time and space.[748]

A no less inspiring characteristic present in Bosch's paintings is the anticipation of surrealism, evident in the way the various elements and their characteristics are combined. Juxtapositions of objects that are not usually found in a single context are present. *Thus Spake Bosch* is similar. The sonic surrealism of Krupowicz is the expressive and dramaturgical foundation whose framework serves to stretch the piece's catenary form.

In addition to the inspiration with Bosch, the title of the work points to another reference, namely to *Thus Spake Zarathustra* by Friedrich Nietzsche. Krupowicz argues that the piece has no direct connection to *Zarathustra*, and that the use of the phrase 'thus spake' is merely the result of a fascination with the German philosopher's work, in which he remained immersed while working on

747 The original version of the piece is a quadraphonic recording. In the version reduced to stereo, this effect entails smooth movement from right to left.

748 The spatial handling of sound through the use of a quadraphonic system completed with a loudspeaker suspended above the audience may also be found in *Twilight* for tape from 1987, which is a collective work by three composers: Krupowicz, Ira Mowitz, and Tony Miłosz. Each of them had previously prepared around twenty minutes of music, which was then 'mixed' into a whole. In one section of the piece, the composers used the sound of a train, which seamlessly transitions into the sound of the sea, so that the listener has the illusion of the train being swamped by waves. The piece was premiered in a church in the Swiss town of Boswil, near Zurich, which helped the composers to achieve a spacious sound. *Twilight* is the only collective work among the works by Krupowicz.



Example 34. Hieronymus Bosch, *The Garden of Earthly Delights* triptych, fragment of *Inferno*

the piece.[749] The distinctive form of the composition may, however, provoke other judgements. The circling and repeated return of the same timbres and textures suggest a reference to the philosophical concept of 'eternal return', articulated in several of Nietzsche's major works, including in *Thus Spake Zarathustra*. However, the markedly abstract content of the piece does not allow one to look for more direct references, leaving its subjective interpretation and evaluation to the listener.

3.1.2. Surconventional palimpsests – algorithmic music for tape and instruments

The *Only Beatrice* is a piece for tape, an amplified string quartet created at the University of Glasgow's Electronic Music Studio. This is one of the few works by Krupowicz in the *musique concrète* genre

749 Private conversation between the author and the composer, Czechowice-Dziedzice, 26 October 2011.

featuring solo vocal parts (the singer who lent her voice to the piece was Dorota Kwiatkowska-Rae). As he attests, 'there is not a single sound on the tape that would not be just another processed form of her voice'.[750]

The compositional means employed by Krupowicz are closely related to the textual layer as well as to the extra-musical meaning of the work. Indeed, its very title does evoke an entire chain of literary associations – from the poem *Spotkanie [The Meeting]* by Jan Lechoń, through the novel *Tylko Beatrycze [Only Beatrice]* by Teodor Parnicki, the film by Stefan Szlachtycz based on the same novel and bearing the same title, to the source: Dante's *Divine Comedy*, in which the Italian poet is given a tour of Paradise by Beatrice. The text of the piece is the conclusion of the poem by Lechoń put into Dante's mouth:

> There is no heaven or earth, no abyss, no hell,
> There is only Beatrice. And she just isn't there.

The poem portrays the longing for and pursuit of a non-existent ideal, its magical power of attraction, and its simultaneous remoteness and elusiveness.

Only Beatrice by Krupowicz is a dreamlike vision – ethereal and unreal. All of the sound effects used in the tape part illustrate and emphasise its transience. The words are spoken in Polish and English, always in a very suggestive manner: sometimes in a soft, warm whisper, sometimes on the verge of screaming and madness. Deconstructing the original text, Krupowicz plays with every word, sometimes – even a single syllable, vowel, or phoneme. Words are repeated many times – sometimes one, and sometimes several at a time – becoming material transformed by the electronics. From each repetition, Krupowicz extracted a different sound, obtaining a kind of imagery within which the overall sense of the piece remains metaphorical and mysterious. As word snippets drift away into silence, the deep reverberation heightens the effect of remoteness. The voice is like a sonic phantom, constantly shifting its position in the acoustic space. Thus, two planes of sound may be distinguished in *Only Beatrice*: the voice and the string quartet, creating two separate musical worlds – the real and the unreal.

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750 Krupowicz, commentary on the piece *Only Beatrice* [in:] *Warszawska Jesień '89. 32. Międzynarodowy Festiwal Muzyki Współczesnej, 15–24 września 1989 [Warsaw Autumn '89. 32nd International Festival of Contemporary Music Warsaw, 15–24 September 1989]*, [programme book], p. 23.

At times, the repetition of the same words makes one pause, while at others it creates tension. Especially dramatic is the final section of the piece, where the poem's punchline, sounding not unlike a verdict, is quoted in a relentless loop: 'and she is just gone'. Elaborate electronic modifications turn it into a sharp, penetrating buzz combined with noise. Contributing to the mysterious atmosphere of the piece is the amplified string quartet part. It is full of glissandi, static textures, and dense timbre bands. It is only later in the piece that the instrumental layer becomes more dynamic. From time to time, he weaves in pseudo-quotations from Baroque music, but the snippets of quasi-Bachian polyphony sound alien and uncomfortable thrown into the new context.

The amplification of the quartet is limited to increasing the volume of the instruments and adding a reverberation effect, while the possibilities of electronics are exploited by Krupowicz more widely when it comes to deforming the voice. By transforming a mere few words, he creates a form lasting over five minutes (just as Włodzimierz Kotoński once concocted an entire *Etude* from a single cymbal hit). One side of the form of *Only Beatrice* is organic, but the other is multi-faceted, texturally, and sonically diverse. It is a post-sonorist electroacoustic poem, full of nostalgia and longing for something distant, almost inexistent.

Another piece composed during his time at Stanford University is *Farewell Variations on a Theme by Mozart* for string quartet and tape.[751] At the time, he was able to make use of a digital conversion of sound samples, which, in 1987, was a novelty.[752] At the same time, the piece is perhaps the most significant example of the use of algorithmisation in Krupowicz's work – the majority of the instrumental parts being generated by computer.

The main theme of the variation is the *Minuet* from the famous *Eine kleine Nachtmusik*, although side themes – such as the vocal-instrumental, abruptly-ended passage from the *Requiem* – also feature as musical symbols. The variationism suggested in the title

751 *Variations* received an honourable mention at the 8th Irino Prize Competition for Chamber Music in Tokyo. This work also exists in a tape-only version, but the composer later withdrew it from the official catalogue (hence this version's name: *W pół drogi [Halfway]*).

752 Toni Miłosz of the PeakDesign studio aided the composer with this. See: Krupowicz, commentary on the piece *Farewell Variations on a Theme by Mozart* [in:] *Warszawska Jesień '06. 49. Międzynarodowy Festiwal Muzyki Współczesnej, 22–30 września 2006 [Warsaw Autumn '06. 49th International Festival of Contemporary Music, 22–30 Autumn 2006]*, [programme book], pp. 76–77.

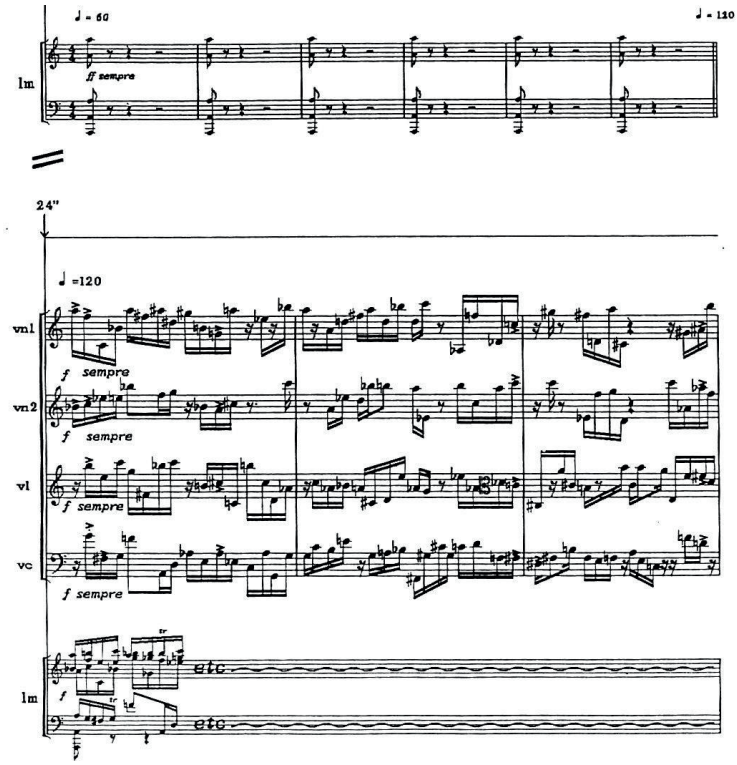
manifests itself in a much individual way; indeed, *Variations* by Krupowicz go much further than traditional examples within this popular genre. In this piece, the Mozartian theme is not so much modified, as completely deconstructed. It is not just the musical structure that becomes the object of the variation, but also, owing to electronic transformations, the sound dimension: 'I operated in the area of texture more so than with the theme construed as melody'; 'the trio sounds like a barrel organ here, even though all the notes are original',[753] writes Krupowicz about the deformation of the *Minuet*'s musical matter. What is more, on fragments of processed recordings of *Eine kleine Nachtmusik* (with altered instrumentation), Krupowicz built his own, sometimes ominous-sounding and often even grotesque sound impressions. Sometimes they are very numerous: 'a large number of sounds creates a new quality, as in the Variations where there are whole segments of perennial sounds, but there are a lot of them. Then, after all, it does not matter whether it's *F*♯, *D*♯, or *P*♯ – what is important is their density, their movement, their microbial macrostructure.'[754] As a result, Mozartian notes are 'sewn' deep into the structure of the piece and remain barely audible.

The form of the piece is made up of two parts connected *attacca*. The boundary between them is not an easy one to pick up on, but of far greater importance is the role of the texturally – and sonically-different phases – the title variations. Over the course of the almost half-hour-long piece, these variations number in dozens. Some are longer, some shorter; some, quite literally, stretch the *Minuet* in time, others tighten it; some change the sound structure of the original, others change its timbre (Mozart's phrases, for instance, are played by a synthesizer).

The role of the musical initiatory gesture is fulfilled by the orchestral signal (quasi-quotation?) played from the tape: a six-fold repetition of the played *tutti,* multiplied in octaves of the *A* sound. The repetition of this pseudo-chord is deceptively reminiscent of the introduction or the coda of some classical symphony. The polar opposite of the transparency of the opening gesture is the first variation that follows – the longest and the busiest. It is based on a dense texture in which long sequences of uniformly-rhythmic sixteenth notes appear in both the tape and string quartet parts. Although they were all generated algorithmically, grasping the logic of these structures aurally

753 Topolski, *Stanisław Krupowicz – interview…*, p. 106.
754 Topolski, *Stanisław Krupowicz – interview…*, p. 77.

is impossible, and even more difficult when it comes to the fragments of Mozart's music. Rather, he aimed to achieve the effect of sonic 'organised chaos', reminiscent of atonal serial textures.



Example 35. *Farewell Variations on a Theme by Mozart* – the beginning of the piece

It is only the fourth variation where one may recognise the *minuet*'s invariant, mainly through its characteristic dance-like metro-rhythm and accentuation. The melody, however, constantly 'limps', as if the musicians were not hitting the notes properly. And it remains so in the variations that follow, which, over time, no longer bear any semblance of Mozart at all. At the climax, Krupowicz adduces a short quotation from the final cadence of the *Requiem in D minor*, followed by several seconds of expressive silence. The final minutes of the piece, filled with sustained bands of sound, relieve the tension built up earlier.

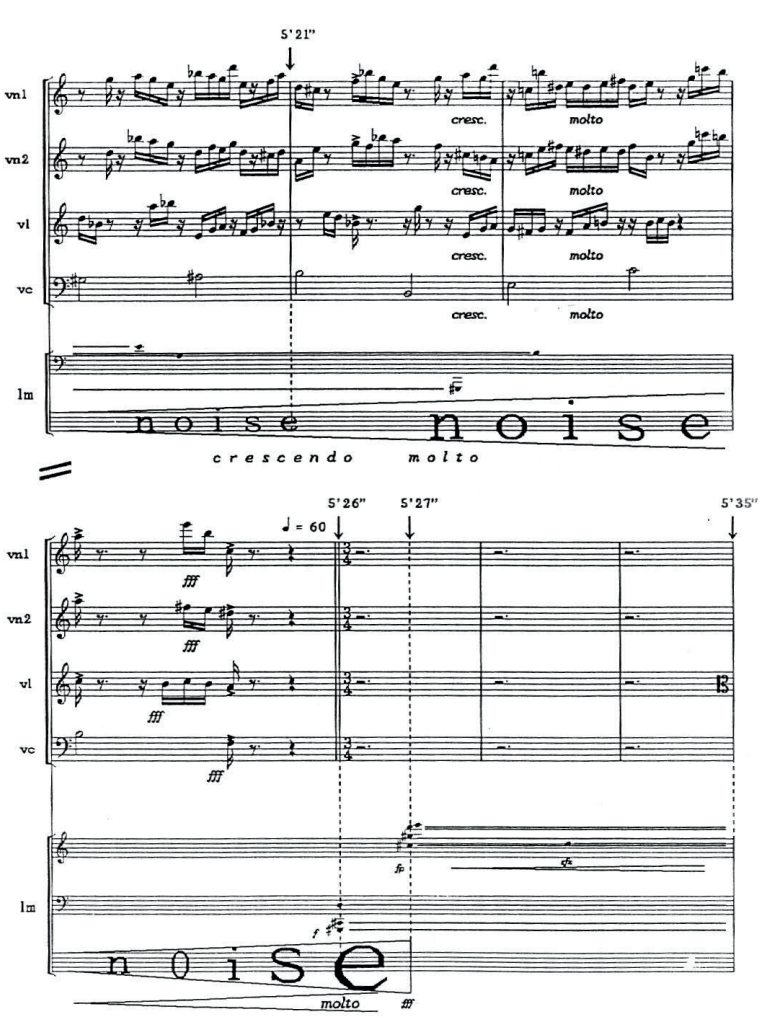
An important role in the *Farewell Variations* is played by noises. He admits that 'noise plays a destructive role, it has a destructive dimension, killing everything, cutting up the episodes of the string quartet and organising the form like a chorus'.[755] True to this statement, it is also noise bands that close the *Variations*.

Despite the postmodern note of irony and the aesthetic disruption taking place in the collage-like juxtaposed variations, Krupowicz does not mock the Mozartian idiom. Certainly, Mozart, as a '*corps étranger*' is sometimes treated *buffo*, but also *serio*. It is not without significance that Krupowicz elected to employ the variation form because, as he stresses, it is 'a form hallowed by tradition'. In his commentary on the piece, he makes several references to a certain characteristic of Mozart's music – namely, the co-existence of comedy and tragedy therein. The composer of the *Farewell Variations* writes: 'this is my imperfect tribute to an excellent composer who knew how to see things as they are: neither funny nor tragic or (…) both funny and tragic at the same time. This is my tribute to his wisdom, which, I must admit, is not easy to attain.'[756] Even while one cannot recognise Mozart's phrases, the listener is left with a visceral premonition of their presence. The *Variations* may therefore be considered an example of a surconventional palimpsest, in which the main dramatic role is played by the disjunction between the 'farewell' beauty of Mozart's music and contemporary sound aesthetics; it is nostalgia for a world long gone.

A Lighter Shade of Grey was created in 1992 and performed at the 'Warsaw Autumn' that same year. The material of the tape part was based on recordings by the improvising ensemble, Tonus Finalis (Chris Chafe, Stanisław Krupowicz, and Frederic L. Malouf). The basis of the borrowed material is a roughly four-minute excerpt, varied in sound and theme, previously used in *Smoking Room Blues*. The entire modification process here is based on the use of comb filters of varying 'thickness' and density. The processing of the source material, along with the change in filter parameters, constitutes the basis of the piece's dramaturgy, producing results both close to the original and

755 Krupowicz also emphasises the role of noise in other works as well: 'In the perception of noises, murmurs, or grinding, our experience becomes crucial. We have a couple of rough-hewn categories – that something sounds similar to a hoover or a stream – and this is, to some extent, a consequence of our listening experience, habits, or musical education.' Topolski, *Stanisław Krupowicz – interview…*, p. 105.

756 Krupowicz, commentary on the work *Farewell Variations…*, p. 77.

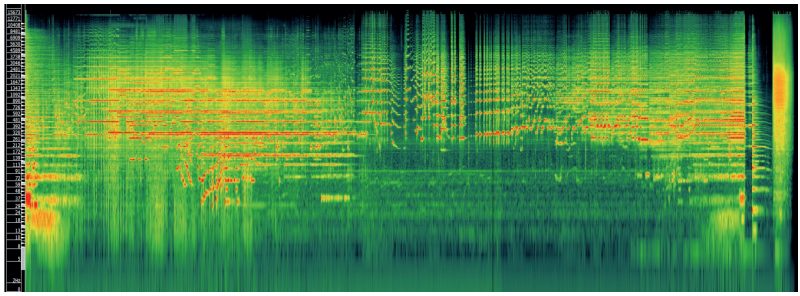


Example 36. *Farewell Variations on a Theme by Mozart* – the final phase of the work

extremely different from it. Owing to the filters, writes Krupowicz, a 'complete picture of the initial material is obtained; as a result of this analysis, I know what, where, when and how it vibrates. Later, I can use this information however I want – assemble it as it was, or, when assembling it, interchange various parameters with each other, e.g. the amplitudes of the components and their envelopes.[757]

757 Here, Krupowicz has assembled the components as in the original. It was, therefore, a case of a synthesis technique known as 'synthesis by analysis'. Topolski, *Stanisław Krupowicz – interview…*, p. 104.

A Lighter Shade of Grey bears the hallmarks of an arched form, while at the same time maintaining textural uniformity and continuity. The piece's spectrogram confirms the presence of frequency-stable timbral bands, both in its first and last minutes. The piece begins with electronic sounds – at first metallic, harsh and penetrating, then, only later, softer, reminiscent of the timbre of strings. They are harmonically stable, anchored around a single pitch (a continuous timbral band), but with a freely oscillating, ever-busier melody.



Example 37. *A lighter Shade of Grey* – the spectrogram of the piece

One may notice that the melody is oftentimes based on a selected sound scale. When the electronic layer becomes silent, the violin becomes active, with its part's composition modelled after a concert cadenza. It is full of expressive motifs – musical gestures in their own right – that are tonally coherent, once again, owing to the use of reduced sound material (reminiscent of Gypsy or Arabic scales). The electronic layer only makes a comeback after a few minutes. It features things like pure tone glissandos (sine waves), superimposed on one another. Their number gradually increases, so that the dense texture is filled with sounds that are non-selective and noisy. Against this backdrop, the violin weaves ever-newer motifs that are repeated in loops. However, there is no agreement between the instrumental part and the electronic part; there is no musical dialogue to speak of here. One may get the impression that the parts do not fit together, representing two different musical worlds. Paradoxically, the sound material of the instrumental part is – according to him – incidentally based on motifs taken from the original material.

While working on the piece and titling it, Krupowicz took his inspiration from an anonymous email, whose punch line read as follows: 'Are we really black or white? Or are we grey and what is

important is the degree of that grey?'[758] The quote takes on a telling significance in the context of art, where subtle nuances, these 'shades of grey', often seem to be those most valuable from the aesthetic point of view.

3.1.3. Electroacoustic interactions – songs using the MIDI system and the synthesizer

When it comes to the dilemmas surrounding the creation of *Concerto for tenor saxophone and computers* (1984–1987):

> It has always seemed to me that the tape, which by its nature is a definitive record of music, not allowing any freedom of interpretation, stood in stark contrast to the essence of creative performance, where such freedom is presupposed. After all, it is the performer who turns the score, being only a rough record of the composer's intentions, into musical concrete; it is through interpretation that each performance of the same piece can be a new and fresh experience.[759]

Thus he was no longer satisfied with a situation in which the soloist would add their part to the reproduced electronic layer, as the tape significantly limits the performance interpretation. Meanwhile, the creator of *Concerto* wanted this layer to emerge during the performance, so that it could be altered on the fly and, perhaps most importantly, so that there would be some interaction – a dialogue – between the parts, just as is the case in the traditional concerto genre.

It was not until the late 1980s that electronic digital media gave Krupowicz the tools that allowed him to solve this compositional and performative problem. Here, the role of the traditional orchestra is taken over here by an opportunely-programmed synthesizer, equipped with a variety of timbres and sound structures. They are controlled using the MIDI protocol. The synth part has a notation, but

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758 An excerpt from an email the composer found in his inbox on 29 August 1992; quoted in: S. Krupowicz, commentary on the work *A Lighter Shade of Grey* [in:] *Warszawska Jesień '02. 45. Międzynarodowy Festiwal Muzyki Współczesnej, 20–28 września 2002 [Warsaw Autumn '02. 45th International Festival of Contemporary Music, 20–28 September 2002]*, [programme book], p. 211.

759 Krupowicz, commentary on *Concerto for tenor saxophone and computer* [in:] *Warszawska Jesień '88. 31. Międzynarodowy Festiwal Muzyki Współczesnej, 16–25 września 1988 [Warsaw Autumn '88. 31st International Festival of Contemporary Music, 16–25 September 1988]*, [programme book], p. 25.

this is not the representation of the initial sound, and may actually be misleading at times. Pressing a single key triggers a single sound at times, while other times it triggers more complex sonic bands or entire sonic structures. The saxophone part also features much variety: fast passages, straight out of free jazz, balance out the slow, melancholic melodies. Keeping with the idea of the classical concerto, at certain points in the work (e.g. at the end of the first movement), he allows the performer to improvise, while himself only determining the sound material or scale. In addition, three microphones are at the saxophonist's disposal. Each of them sends an acoustic signal to the effects processor, which transforms the natural sound of the instrument in various ways – adding a reverb or phaser effect, etc.[760] Thus, the soloist may change the sound in real time, by moving the instrument's sphere closer to the individual microphones.

Despite the innovative performance solutions, it is not difficult to see many features typical of the genre in *Concerto*. The piece consists of four different movements, with the third and fourth – by far the longest – joined *attacca*, making the form similar to the classical three-part structure. The first of the movements (*Preludio e cadenza*) consists of a lengthy synth introduction (reminiscent of an orchestral exposition) and a saxophone cadenza. In the second, slow movement (*Adagio molto e cantabile*), he weaves into the saxophone part quotations from the famous medieval song *L'Homme armé*, and from the Polish religious song *Święty Boże* into the synthesizer part (which is probably why the work was originally to be called *Motet*). The timbres employed by the composer add to the mysteriousness of this part of the piece. The synthesizer layer only uses two types of timbre: a noise-choir timbre (or 'pad') and a percussive one (a combination of drum and tam-tam sound), whose threefold exposition – like a beat – closes each phrase. The third and fourth parts (*Senza indicazione e Insopportabilmente leggero*) are the most expressive of them all. The synthesizer part often becomes stratified, at times introducing aggressive motivic content and sharp, characteristically electronic sound. Owing to the appropriate construction of timbres, the part densely fills the entire sonic space, fulfilling the role of an electronic orchestra of sorts.

760 The phaser adds an effect of fluctuation to the sound. Its working principle entails shifting the phase of an acoustic signal by means of a filter whose pass frequency varies in time.

In *Concerto*, Krupowicz touches on one of the most important problems in the performance of electroacoustic music. In a certain sense, he transferred the studio efforts to create a permanent tape recording to the stage; the piece 'comes alive' in the concert setting. The synthesizer, computer and electroacoustic apparatus play a role here just as much as do the piano, violin, or any other instrument of the orchestra. The issue of the 'persistent struggle with a soulless mechanism' was solved, and *Concerto* by Krupowicz became one of the first Polish works in the live electronics genre.

Smoking Room Blues for a MIDI ensemble from 1991 is 'a modest tribute to the music of Black America',[761] which, according to Krupowicz, represents the most significant American contribution to the world's musical heritage. This tribute is paid through the reference to a musical genre characteristic of early 20th century African-American culture: 'as far back as I can remember, I have never been able to stay indifferent to the blues. Why? – that was the question I had asked myself'.[762]

The piece was composed with the improvising performance ensemble, Tonus Finalis, in mind. This ensemble is made up of musicians who are both composers and performers. It includes Chris Chafe on celletto – an electric cello without a sound box, but integrated with effects processors, Frederic L. Malouf on electric guitar (also combined with effects) and Krupowicz himself on keyboards (synthesizers). The final form of each performance is the product of a joint composition-improvisation by all members of the ensemble. The instruments change their timbres through the use of MIDI, becoming external sound controllers. The title of the piece bears amusing connotations: Krupowicz, being a compulsive smoker, constantly struggles to find a place where he would be able reach for a cigarette without interruption. Hence the humorous nature of the commentary on the piece as well as the title.

Certain Specific Cases of the Generalized Perfect Authentic Cadence for synthesizers and computers (1995) is also an improvised piece-project. His sound presentation was combined with a performance by Ryszard Piegza, who at the time practised a genre of art he called 'maiden sculpture' and would assemble

761 Krupowicz, commentary on the piece *Smoking Room Blues* [in:] *Warszawska Jesień '91. 34. Międzynarodowy Festiwal Muzyki Współczesnej, 20–29 września 1991 [Warsaw Autumn '91. 34th International Festival of Contemporary Music, 20–29 September 1991]*, [programme book], p. 28.

762 Krupowicz, commentary on the piece *Smoking Room Blues…*, p. 27.

a spatial structure out of various, sometimes random, elements before the audience's eyes. The structure was built upwards, although its only source of cohesion were the attempts at finding a point of equilibrium, and the search for this point generated tension and performative action. The sounds generated by the electronics controlled by Krupowicz were, in turn, intended to illustrate the construction of the sculpture and musically add to it. A common feature of these activities was that both Piegza and Krupowicz had a limited number of building blocks at their disposal. This allowed durable correlations to occur between the sculptural activities and the emerging sounds. During these performances, Krupowicz would use various types of synthesizers, which were, in turn, integrated with a computer programme constructed in the Max/MSP environment via the MIDI protocol. The final, strongest accent of the performance was to upset the balance of the meticulously-constructed sculpture so that the structure collapsed with a loud crash.

Further joint performance performances, being a direct continuation of this project, followed: *Terre Minus* (1998) and *Tous Ensemble* (1999).

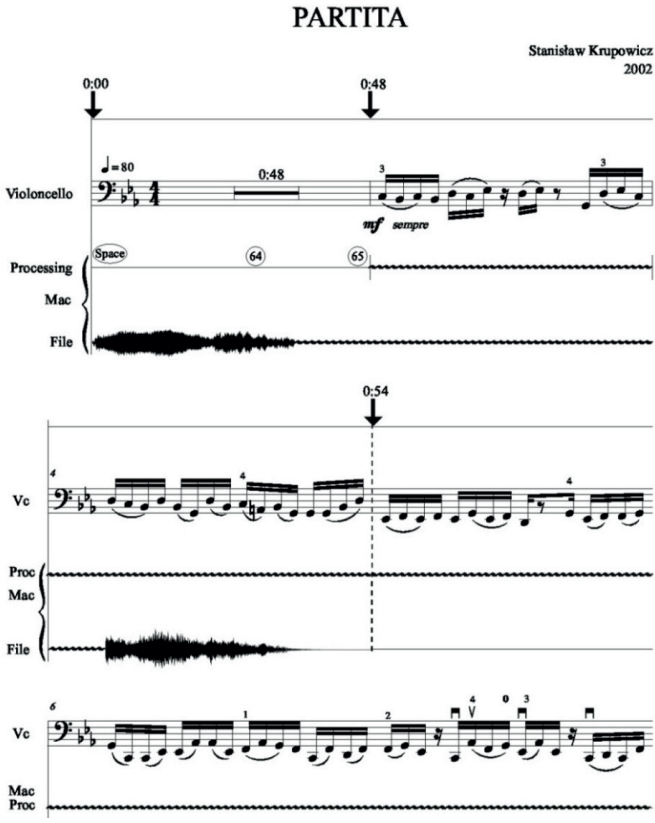
3.1.4. Instrumental hybrids – algorithmic music for instrument and computer

Composed in 2002, *Partita* for cello and computers was commissioned by Andrzej Bauer, and became part of his composer-performer project called Cellotronicum.[763] He explained the formal shape of the work as follows:

> The variations, or rather the variety of their forms, might make one lose their mind. And, although I would like to finally compose a piece not being some kind of variation, somehow, I am not succeeding. Defining the form of *Partita* for cello and computers raises some difficulties. 'Partita' seems to be the best-fitting term, although one could also describe it as an Old French rondo with a variation of the refrain.[764]

763 Andrzej Bauer's premise is to inspire and perform music for solo cello and electronic media. The project already includes more than a dozen works written by outstanding composers, mostly from Poland.

764 Krupowicz, commentary on the piece *Partita*…, p. 113.



Example 38. *Partita for cello and computers* – beginning of the piece

Indeed, the form of the partita may resemble a rondo. Here the motoric, cooing passages performed by the cello act as a form of refrain. The entirety of its part is generated by a piece computer software that drew notes from a six-step scale: *C*, *D*, *E*♭, *F*, *G*, *A*♭, and, in the phase of the piece that follows, used the rest of the tones the chromatic scale: *B*, *C*♯, *E*, *F*♯, *A*, *B*. These sounds are arranged in homogeneously rhythmic sequences of various lengths, punctuated by pauses whose duration is also determined by an algorithmic technique. Krupowicz treats the cello somewhat 'soullessly'. He does not exploit the timbral, expressive and dynamic potential of the instrument, instead concentrating on the structure of the sound material, which is filtered by the computer and modified timbre-wise (using the GRM Tools software). In turn, the sounds generated during the performance are modified by things like various comb filters. He admits that Andrzej Bauer – the

addressee of his dedication and the work's first performer – 'was somewhat disappointed when he had heard for the first time what the computer had been doing to his artful, perfect performance of the cello part in real time'.[765] But these were exactly the results Krupowicz expected. As rightly stated by Tomasz Cyz: 'in the *Partita*, rooted in the Baroque model, the most important and interesting thing seemed to be the struggle between the sound of the cello extracted from the score and the computer-recorded tissue.'[766] During the premiere, the computer processing was supervised by the composer himself, but, as of current, he is working on the ability to leave this to the cellist.

In the case of *Prolongement* for string quartet and computer (2009),[767] the key to reading the piece lies in the title (from the French word prolongement meaning 'prolongment'), referring to the third, middle piano pedal. In fact, the role of electronic media here is to implement a virtual third pedal of sorts to the quartet playing in the piece. The parts played by the individual instruments are run through and analysed by a piece of computer software that generates the same pitch, corresponding to the strings somewhat. This results in a sound-stopping effect, which is, however, different from a simple reverberation or delay line effect. By the time it is played back, the computer is analysing the next one already, combining successive sounds through glissandi. Thus, all the action takes place with a delay of one note, so that the computer has enough time to analyse the acoustic waveform.

The computer-generated sounds are obtained using a subtractive method[768] from the pink noise, by applying opportunely-parameterised comb filters. This is evident at the beginning of the piece – the initial sound of explosion or thunder is quickly replaced by noise, which is gradually filtered electronically so that it turns into a single sound band, smoothly glissandoing upwards to the ceiling of a quiet, screeching *B2* sound. This, in turn, aligns and interlocks with the first sound of the violin.

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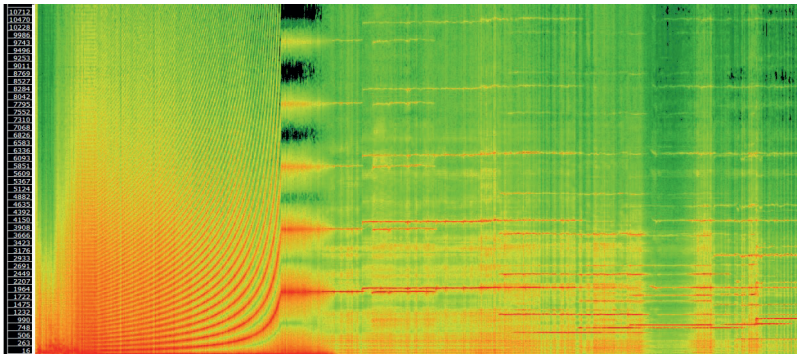
765 Topolski, *Stanisław Krupowicz – interview…*, p. 104.

766 Tomasz Cyz, [no title], *Tygodnik Powszechny*, 2002, issue 40, http://www.andrzejbauer. com/proj_cellotr.html.

767 It was first performed at the Katowice Festival of Premieres on 28 March 2009 by the Silesian Quartet and the composer, who performed the electronic layer.

768 Subtractive synthesis involves the subtraction of harmonics and filtering. Cf. Chapter 2.2.



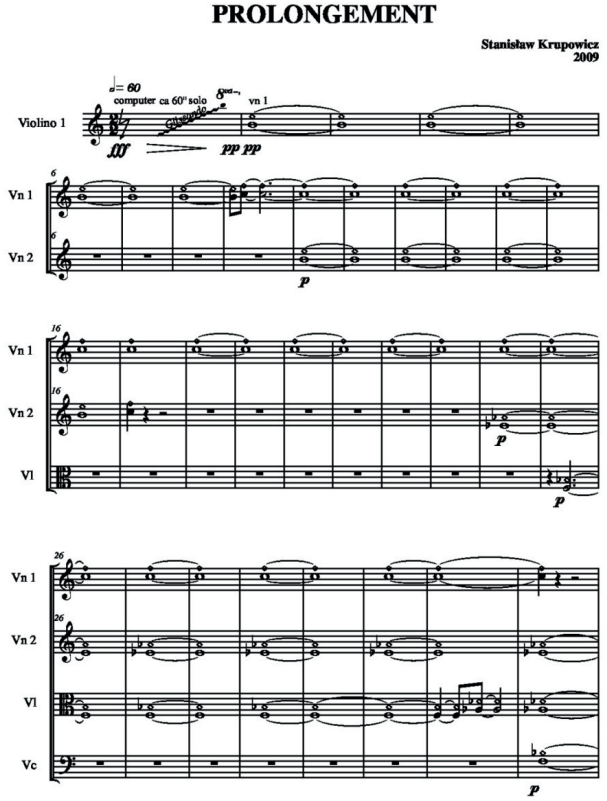
Example 39. Spectrogram of the first three minutes of *Prolongement*

When the other instruments of the quartet play, a certain kind of sound band is created, with its shape sometimes resembling a chord (when the timbres are structured consonantly), and sometimes a cluster (when the intervals between the individual voices decrease and the band thickens). The sounds – components of the sonic bands – undergo smooth, sometimes glissando-based changes. Importantly, some of the consonance verticals, if condensed time-wise, would resemble cadence phrases.

Over time, the quartet's parts are enriched with electronic sounds that create streaks of sorts, but no longer chordal or cluster – rather, they are noises. By employing the appropriate filters, the composer extracts individual sound bands from these noises and operates them in both the acoustic space (the pan setting) and the pitch-sound space (glissandos). Furthermore, Krupowicz constantly varies the degree of texture density and dilution, as well as that of co-sound dissonance. The ending of the piece is a reversal of the principle guiding the beginning: the sonic strands seamlessly change into a noise that 'clamps' the form together.

The live electronics sounds in *Prolongement* have been aptly described to be like 'smoke dropped between the sounds of the instruments'.[769] Maciej Jabłoński, on the other hand, saw the piece as a world of 'noisy electronic sounds' in the piece, though 'the electronic layer seemed monotonous, uninteresting, and too loud – I could hardly

769 Editorial, *Musica Electronica Nova*, 10–17/05/2009, http://www.nowamuzyka.pl/2009/08/10/Musica-Electronica-Nova-10–17-may-2009/.



Example 40. *Prolongement*, beginning of the piece

hear the quartet at all.'[770] The extreme, nearly-boring homogeneity of the sound material in *Prolongement* is not a typical feature of Krupowicz's compositional technique. The form here, however, is entirely subordinate to an overarching idea directly related to the use of electronic media.

The piece *T o p L a p* (which the composer also presented under the name *Muzyka najwyższego splotu [Music of the Highest Coil]*[771]; 2009) is a computer quartet that is part of a trend called *laptronica*.

770 Maciej Jabłoński, *Euzebiusza z Florestanem dialog o nowościach. III Festiwal Prawykonań, Katowice, 27–29 marca [The Dialogue about Novelties between Eusebius and Florestan. Third Festival of First Performances]*, *Ruch Muzyczny*, 2009, issue 9, p. 12.

771 The title *TopLap* is a play on words: on the one hand, swapping the syllables within the word 'laptop', and on the other creating a new meaning, as in 'the highest lap'. Hence the alternate Polish title that translates into *Music of the Highest Coil*.

Here, three performers 'assemble' a piece live, employing nine algorithms to generate the music. The fourth 'performer' is the computer itself, which, depending on the choices made by the others, executes the previously-written score. In TopLap, the algorithm is a mathematical formula[772] that determines the rhythmic layer of the piece – to be more precise, the durations of the individual notes. Additive synthesis was also employed here, shaping sound bands made up of 16 component tones. Moreover, he used the old mesotonic tuning system, giving a distinctive sound to certain intervals, especially thirds.

3.1.5. Opera with a vision – multimedia projects

The one-act computer opera *E u r o p e*, composed in 2004 to a libretto by William Blake, became the third piece in a series commissioned by the 'Warsaw Autumn', inspired by *The Land of Ulro* by Czesław Miłosz. The previous two were written, respectively, by Martijn Padding (*Tattooed Tongues*) and Osvaldas Balakauskas (*La Lointaine*). The individual parts of the opera triptych draw on the thoughts of three precursors of a 'contemporary revival of spirituality'[773]: Emanuel Swedenborg,

(Padding), Oskar Władysław Miłosz (Balakauskas), and William Blake (Krupowicz). These works, although intended to form a cycle, are presented separately and remain distinct, differing in titles, lineups, and formal concepts. They are united only by an overarching idea derived from Milosz's work: vision.

Much of *Europe*'s musical material, especially the vocal parts, was generated using the Max/MSP software patch. Krupowicz recalls working on the piece thus: 'it [the software – note by A.M.] composed on its own, and I kept what I liked. Later, I glued it all together and assembled it.'[774] The co-producer of this performance was Cezary Duchnowski, who wrote most of the monitoring and control software.

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772 According to the composer himself: taken from the theory of a Russian mathematician from the early 20th century. Private conversation between the author and the composer, Czechowice-Dziedzice, 26 October 2011.

773 Szwajgier, *Ziemia Ulro [The Land of Ulro]* [in:] *Warszawska Jesień '04. 47. Międzynarodowy Festiwal Muzyki Współczesnej, 17–25 września 2004 [Warsaw Autumn '04. 47th International Festival of Contemporary Music, 17–25 September 2004]*, [programme book], p. 92.

774 Tutka, *Europa Stanisława Krupowicza*…

When it came to working on the piece, the primary tool was the computer: simultaneously, it operated the sound generator, the virtual synthesizer, and the musical instrument.[775]

Four sound systems were used for *Europe*'s production, as the sound files were assembled using four channels. Each soloist was equipped with their own contact microphone and clip-on microphone (the choir parts being amplified using two condenser microphones suspended above the stage), through which the acoustic signal travelled to the computer. There, it was amplified and slightly modified, then it triggered further transformation modules operating in real time.

Krzysztof Szwajgier believes *Europe* to be closer to the concepts contained in Czesław Miłosz's work than the other opera productions based on *The Land of Ulro*:

> It was no coincidence that this time the composer chose Blake's poem distinguished among the others for the unbridled dynamism of its vision and, in some respects, its visionary relevance to ourselves. Its complement must be sought in Imagination (a term central to Blake's thinking about art). *Europe* by Krupowicz supports it by means of musical allusions and understatements, the ambiguity of the images, the static form, the long stretches of computer-released sounds, and the lack of textual continuity. The essence of the symbolic entities inhabiting Blake's world is not fully transferable. To a certain extent, however, it can be brought closer – both here, and in the entire *The Land of Ulro* cycle – by music, supported by means of theatrical illusion.[776]

In his commentary on the work, he explains that the content of *Europe*'s libretto is based on two main themes, and simultaneously two of the supposed greatest mistakes of mankind identified by Blake: 'In diagnosing Europe's decline, Blake pointed to two fundamental causes of it: a falsely-interpreted, mispractised Christianity, and a belief in the redundancy of all religions.'[777] In the light of current

775 During the premiere, two Macintosh computers were used; one processed the live sound, and the other controlled the other parameters, including volume and reverb.

776 Szwajgier, *Ziemia Ulro…*, p. 95.

777 Krupowicz, commentary on the piece *Europe* [in:] *Warszawska Jesień '04…*, p. 96.

events and the changes taking place on the Old Continent, the issues raised by the English precursor of Romanticism, then recalled in *Europe* by Krupowicz come across as exceptionally relevant.

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'Art without science is nothing' – this famous adage from the 14th century by Jean Mignot was posted by Krupowicz on the home page of his website.[778] It is not merely a motto, but also a meta-idea constantly present in his work. In fact, the composer is constantly employing the benefactions of science in their various aspects, by virtue of his education and interests – chiefly mathematics and computer science. He generally does not write sheet music or compose scores by hand. He works at the computer which, opportunely programmed, generates the sounds and their record by itself. The range of technical capabilities of modern computers is rich enough to allow one to choose the tool that is simultaneously the most convenient and the most effective.

In electronic media, Krupowicz has always been fascinated by the possibility of formalising compositional processes and sound combinatorics, i.e. a l g o r i t h m i s a t i o n. It primarily consisted in constructing mechanisms that shaped sound structures as well as their interrelationships and configurations, but not the sounds themselves. Krupowicz understands algorithmisation in a very broad sense. He already considers any method of composition or even a pattern of procedure to be an algorithm:

> We constantly use algorithms in our daily lives, even when brewing coffee. Typically, we do not pay this much heed and are often not aware of it. All composers – without exception, including those who sit down and improvise in divine inspiration – make use of algorithms as well. Some are aware of this, others hypocritically do not admit it, while others still do not know it at all. There are composers who cannot even imagine that it is possible to write differently from the way they write typically; and yet, they believe themselves free. And yet, it is just their routine, their method of composition, their algorithm. If a classically-trained pianist sits down at the piano and plays a metaphysical improvisation, they will still be using the passages and configurations of sounds they have in their fingers, i.e. their algorithms.[779]

778 See: http://web.me.com/magda.elzbieta/skrupowicz/Home.html (access: 21 July 2014).

779 Topolski, *Stanisław Krupowicz – interview…*, pp. 104–105.

In each of his electroacoustic works, Krupowicz employs – in various ways – the algorithmic technique. 'I am incapable of functioning otherwise. It's an organic necessity for me, just like breathing,'[780] he admits. Writing and using scripts and computer software 'can be a real intellectual adventure, highly exciting and engaging in and of itself',[781] he adds. Algorithmisation permits the creator to achieve the balance needed in the work between the elements of chaos and order, dispersion and integrity, between the surprising and the anticipated, or, to put it even more generally: between chance and necessity.

Krupowicz's approach to shaping the musical form is an original one. He expresses this in, among other things, his commentary on the work *Thus Spake Bosch*:

> The 'Multiplicity of Unity' or 'Unity of Multiplicity' are pure illusion and mystification. Nothing connects to anything, nothing results from anything, there are no causes or effects. There is no world of ideas or monads, and there is no essence, thus any reduction, eidetic though it might be, is but a vain rearrangement of objects, or rather words, which were probably invented specifically for the needs of this useless game. The regularity one may sometimes perceive, e.g. that of a cloverleaf or an octave, is the result of imperfections in our vision and the insufficient precision of our hearing system. Anything can precede anything, and anything can follow anything, not to mention that there is nothing that could not coexist with anything else. The ordering role of time is yet another illusion and simplification, as is necessity. 'Impossibility', after all, is so utterly ordinary.[782]

The listener need not (or should not, even) understand the rules governing the piece. Feeling them subliminally is enough. This is why, for Krupowicz, balancing on the edge of perceiving the internal logic an essential quality of the piece. He compares a well-composed piece to a labyrinth that surprises one with new corridors at almost every turn.[783] Its imaginative structure makes one want to keep going, and, while looking for an exit, want to lose themselves in it at the same

780 Topolski, *Stanisław Krupowicz – interview…*, p. 106.

781 Topolski, *Stanisław Krupowicz – interview…*, p. 106.

782 Krupowicz, commentary on the piece *Thus Spake Bosch* [in:] *Warszawska Jesień '90. 33. Międzynarodowy Festiwal Muzyki Współczesnej, 14–23 września 1990 [Warsaw Autumn '90. 33rd International Festival of Contemporary Music, 14–23 September 1990]*, [programme book], p. 76.

783 Private conversation between the author and the composer, Czechowice-Dziedzice, 26 October 2011.

time. The means accompanying similar aspirations oftentimes cause the listeners of works by Krupowicz to look for a plot line of sorts, trying to read this supposed 'programmatic nature' hidden in the background. The compositional process, however, is not supported by any manifestation of programmaticity – the idea of the piece is usually purely abstract in nature. Usually, at the core of a composition lies a formal and technical idea, some musical-mathematical (or computer science) problem. The piece then becomes the task that serves to solve that problem.

In the course of the work, the abstract idea – the main idea of the piece – acquires a soundtrack, its own shape and form. When a traditional line-up is involved, the composer assumes a certain formal skeleton – a 'canon with heads ripped off'.[784] In contrast, the material is imagined in a very general manner: 'dense, loose, high, low'. The situation is quite different if the composer works in a computer studio based on the selected material – pre-recorded or generated – which 'provokes some particular processing and then assembling it into a larger whole. The form is then often, in a certain sense, forced by the material, but this does not mean that it cannot be shaped freely.'[785] In each of these cases, the organisation of material cases at a lower level is typically handled by Krupowicz at the very end. The most important factor is the macro-form and the consistency of its design. It may, of course, be varied, either for higher aesthetic purposes or in order to break up the monotony. Once the idea hidden in the piece starts to become apparent, it is important to move away from it, lest the piece become predictable, and, therefore, tedious. The listener's attention, says Krupowicz, must be constantly exposed to new stimuli, new ideas, and new logic. In an optimal situation, the numerous surprises and breakthroughs are balanced out by some overarching idea, but the listener does not need to be aware of its rules – a sense of their existence is sufficient. In organising the material, the composer not uncommonly draws on experiences and ideas developed within serialism, but does so in a highly free and individual manner. Melody or harmony are usually not shaped directly, but rather through algorithms. The composer assigns their general features (e.g. numerous intervallic leaps, avoidance of chordal progressions, diatonic), but the order of the individual pitches is randomised, or, as one might like to say – improvised by a computer

784 Topolski, *Stanisław Krupowicz – interview…*, p. 104.
785 Topolski, *Stanisław Krupowicz – interview…*, p. 104.

program. This way, the composer relinquishes the responsibility for the final form of motifs or phrases without losing control over the overall melodic phenomena.[786]

Krupowicz often draws on the same types of sound by modifying, refining and complementing them. In his works, he repeatedly employed synthesised human voice (*Music for S*, *Thus Spake Bosch*), string instruments, harpsichord and – sometimes with a symbolic dimension – various types of noise (*Farewell Variations*). When looking for a new, 'imagined' timbre, he does so by trial and error, hoping to come across something interesting by chance. He often juxtaposes different types of sound media: classical, homogeneous (usually string instruments, such as the string quartet) and electronic, texturally and sonically diverse. At times, especially in the earlier works, a predilection for synthetic but imitative natural sounds is apparent.[787] On the one hand, the similarities to the timbres of traditional instruments make the sounds more real, and, on the other, owing to the means used, give create an image of hyper-instruments with unlimited technical possibilities. Sometimes, in fact, it is these very similarities and differences that have a pivotal meaning for the expressive and dramatic layer of a work.

Krupowicz's declared affiliation to the new, original aesthetic and musical trend known as s u r c o n v e n t i o n a l i s m, created together with Paweł Szymański, is a separate issue. It is evident in his use of pseudo-quotations from Baroque music (*Thus Spake Bosch*) or classical music (*Farewell Variations on a Theme by Mozart*), as well as in his evocation of certain characteristic, easily recognisable idioms and conventions. According to the surconventional idea, for Krupowicz, music is the art of creating contexts. The symphonic *Fin de siècle* (1993), in which the composer builds form and narrative using stylistic 'clichés' of 20th-century music, may be considered a model example of musical surconventionalism. Here, the aim was to employ familiar and recognisable compositional techniques, thus

786 The need for at least an implicit logic means that Krupowicz is not interested in practising free improvisation, so in vogue among many composer--electroacousticians. The creator believes that each musician is burdened with certain habits and favourite phrases. Besides, making music together without any preconceived rules may become pointless and monotonous.

787 'In my opinion, the breakthrough (…) was not that the computer started pretending to be a clarinet, but that it was possible to construct such sounds using a computer at all. By way of trial and error, we are able to get closer to the various timbres imagined, which is exceptionally stimulating.' Topolski, *Stanisław Krupowicz – interview…*, p. 104.

a quasi-baroque canon in C minor, in fifths and fifths, was created for the piece. Then, underneath the specific, individual notes of the canon, Krupowicz has set whole musical structures (and textures), evoking various historical compositional techniques. It is only towards the end of the piece where the creator, in order to break this idea, does introduce an original canon form. As a result, the intended eclecticism yields a work that is, on the one hand, integral and sovereign, and on the other, catalogue-like, collage-like, a 'play on styles' of sorts. The ideas of Krupowicz present in similar works (*Thus Spake Bosch*, *Farewell Variations*) are often close to postmodernist ideas of composing 'music about music' or 'music within music'.

Krupowicz belongs to a generation of composers building their own original poetics and aesthetics, independently of the older generation of 'masters'. New media are of paramount importance here, enabling and facilitating the composer's achievement of his individual artistic goals and making it possible to combine his computer- and mathematics-related interests with music-making. The vast possibilities afforded by new media in this area continue to inspire Krupowicz, as does the idea of creating a tool – an algorithm, a piece of software – that would no longer merely be able to generate and process music, but also intelligently interpret it not unlike a live, human performer. The creator would like such software to be able to find its way around the score, to adapt the tempo and dynamics to the other performers, and be able to interpret the gestures of the conductor or lead performer. The programming problem here lies chiefly in correlating the auditory and visual elements, while at the same time excluding additional human assistance. The idea of creating a musical artificial intelligence is not only a musical or informatic problem, but also an ontological one. After all, should art created in this way be considered more the work of man, or machine?

3.2. Sound, space and expression in works by Magdalena Długosz

Magdalena Długosz (b. 1954) has been affiliated with the Kraków Academy of Music[788] since the beginning of her creative career – she is an alumna of Krystyna Moszumańska-Nazar (composition) and

788 As a professor and Head of the Hearing Education Team (since 2008), he develops innovative methods of teaching ear training using the computer and dedicated, interactive software. Cf. M. Długosz, *Solfeż komputerowy. Wspomaganie procesu kształcenia słuchu muzycznego poprzez użycie*

Józef Patkowski (music theory). Her aesthetics were also heavily influenced by the milieu of her home Electroacoustic Music Studio, the Polish Radio's Experimental Studio in Warsaw, as well as key figures associated with the studios located in Paris and the USA.

From the 1980s onwards, Długosz collaborated with many major centres of electroacoustic music. As a scholarship holder, she created works at the EMS (Elektronmusikstudion) in Stockholm (*Pulsations* for tape, 1983), at the CECM (Centrum pre Elektroakustickú a Computerovú Hudbu) in Bratislava (*At the Source* for tape, 1990–1991), at GRAME (Groupe de Recherche Appliquée en Musique Electroacoustique) in Lyon (*Lenyon* for tape, 1994–1995), at IMEB (Institut International de Musique Electroacoustique de Bourges) in Bourges (8-channel *Beyond Silence*, 2007–2008). 'Owing to the people I met and their inspiration,' she writes, 'I realised relatively quickly what would become (…) the goal of exploration and experimentation in my work. Namely: timbre, space, microtonality, tension and expression, and interpretation'.[789] These aspects have become the main issues discussed in the present chapter.

3.2.1. Virtualised instrument – acousmatic music

In the first period of her creative work, in the 1970s and 1980s, Długosz enriched her compositional skills when it came to timbre by exploring the possibilities of sound synthesis (including wave table, additive, subtractive, and FM synthesis) and computer programming using the C-Sound language. In the music for tape that was created at the time, one may distinguish pieces using the timbres of the synthesizers available at the time. Długosz used a Buchla analogue synthesizer in *Pulsations* (1983), an analogue-digital PPG Wave 2.3 in *Mictlan I* (1987), the popular Yamaha DX7 and TG81Z module and an Oberheim Matrix-1000 analogue in *Yes and No* (1990); a Kurzweil K250 sampler and an Ensoniq VFX synthesizer/sampler

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elektronicznych instrumentów muzycznych i komputera [Computer Solfege. Supporting the Process of Musical Ear Training through the Use of Electronic Musical Instruments and a Computer] [in:] *Wychowanie muzyczne i nauka o muzyce wobec przemian kulturowych i cywilizacyjnych [Musical Education and Learning in the Face of Cultural and Civilisational Changes]*, ed. Janusz Zathey (Kraków: Wydawnictwo Akademii Muzycznej w Krakowie, 2003).

789 Magdalena Długosz, *Summary of professional accomplishments*, https://www.amuz.krakow.pl/wp-content/uploads/doc/magda_dlugosz__autoreferat.pdf (access: 21 September 2026).

in *At the Source* (1990–1991). In *Lenyon* (1994–1995), she made use of the timbres offered by the Akai S1000 sampler, combining them with her own sound samples.

The synthetic sounds of the electrophones used hitherto did not meet her aesthetic expectations. Sensitised to the timbral quality and nobility of acoustic instruments, she decided to use them to shape the sound matter of her works. 'I found,' said Długosz, 'that the richness of instrumental sound was second to none,'[790] thus she embraced the digital means employed in *musique concrète* and acousmatic music. Thus, the material for subsequent works was made up of recordings created in collaboration with selected performers, including violinist Kaja Danczowska (*Ombrarchetto*, 2003), cellist Andrzej Bauer (*Abamus*, 2003–2004) and flautist Renata Guzik (*Ocean City*, 2007; *Beyond Silence*, 2007–2008).

The first work of this kind was *TaBaMa* (1997–1998), where the sound material consisted of recordings made by her in the studio of the Polish Radio in Warsaw in collaboration with double-bassist and composer Tadeusz Wielecki and sound director Barbara Okoń-Makowska.[791] Wielecki, well-versed in the various articulation and performance techniques he explored in his work, performed on double bass and recorded a number of various sound sequences, based on the composer's instructions prepared in the form of pre-compositional note drafts. The resulting diverse sound material became the basic material for the compositions produced in the ProTools system (digital audio workstation) and the GRM Tools application. These tools boast very broad processing capabilities. 'The computer,' she writes in her commentary, 'helped with the transformation of the double bass sound, precise editing, multiplications, and collisions of diverse structures.'[792]

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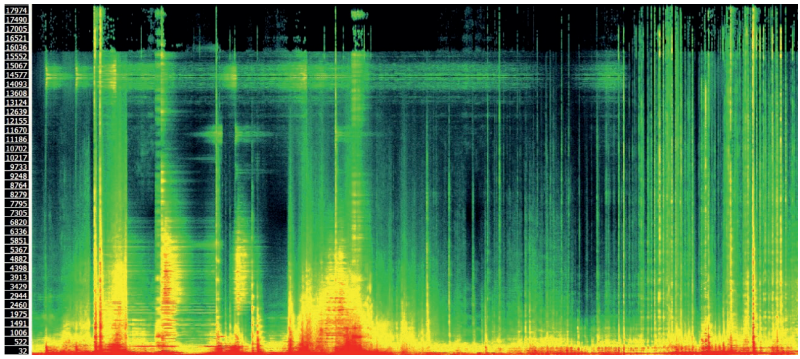
790 Długosz, quoted in: Dominika Adamek, *Materiał instrumentalny w wybranych utworach elektroakustycznych Magdaleny Długosz [Instrumental Material in Selected Electroacoustic Works by Magdalena Długosz]* [unpublished Master's thesis] (Kraków: Akademia Muzyczna w Krakowie, 2012), p. 29.

791 The title of this piece is an acronymic palimpsest of sorts, hiding the names of those involved in the creation of the work: The 'Ta' part refers to Tadeusz Wielecki, the double bass player, 'Ba' to the recording engineer Barbara Okoń-Makowska, and 'Ma' to the composer.

792 Długosz, commentary on the piece *TaBaMa* [in:] *Warszawska Jesień '99. 42. Międzynarodowy Festiwal Muzyki Współczesnej, 17–25 września 1999 [Warsaw Autumn '99. 42nd International Festival of Contemporary Music, 17–25 Autumn 1999]*, [programme book], p. 71.

Multiplying and grouping sounds of similar morphology into more elaborate structures and textural formations creates a 'sound constellation' of sorts here. The individual 'constellations' form higher-order structures or are juxtaposed in contrast, allowing one to distinguish three phases in the piece: the first, less than four minutes long, abounding in noisy sounds, narrow-band glissando motifs, vibrating and fluctuating, set primarily in the low register; the second phase, lasting until the tenth minute, internally differentiated and with increased rhythmic and textural density, but with a quasi-percussion sounds playing the dominant role; finally, the third phase, at first resolving the tension by reducing the dynamics and diluting the texture, but then unexpectedly leading to a final climax, followed by the 'fading' of the piece.



Example 41. A spectrogram showing textural changes in *TaBaMa* (second phase – 5'00"-6'30")

Individual motifs, sound figures, or whole textural plans are laid out in space in different ways, which is why the piece was produced in an octophonic (8-channel) version.[793] Długosz was, in fact, concerned with creating in *TaBaMa* 'the illusion of sound moving freely in a multi-dimensional space, achieving variable depth and perspective, etc. Over the course of the piece's production, the vision of a "virtual double bass player" moving through a fantastic acoustic space never

793 In order to play the basic octophonic version, an eight-track ADAT digital tape recorder or a computer with appropriate software is required, so as to enable control of the parameters of the individual tracks, taking into account the acoustics of the room. *TaBaMa* also has a simplified, stereo (2-channel) version, performed when only two loudspeakers are available. Both versions of the *TaBaMa* piece (8-channel and 2-channel) were created at the SME in Kraków.

left me.'[794] The keywords here are 'virtual double bass player' and 'acoustic space'. Owing to the use of the studio's capabilities, the spatial distribution of the double bass sound and the range of its timbral and expressive qualities were given a new, expanded form in the tape part, impossible to achieve using 'purely' acoustic means.[795] Thanks to the projection of sound through a multi-channel speaker system, the listener is able to experience a kind of acoustic immersion and complete immersion in the sonic world created by the composer – virtual, but also rooted in an 'instrumentality' of sorts.

3.2.2. In the chamber of mirrors – pieces for tape and instruments

The general tendencies in electroacoustic music indicate that a current of creating works by combining tape with traditional instruments has become more popular over time than 'pure' tape music. The music for tape by Długosz was also increasingly enriched by the presence of an instrumentalist, starting with *Visus* for 5 instruments and tape (1978), composed while she was still a student, through *Mictlan II* for accordion, digital reverb device and tape (1988), *Patjan* for percussion and tape (1996–1997), *TaBar* for electronically-transformed double bass and computer sound layer (1998–2000), *Ombraggio* for violin and electroacoustic layer (2002–2003), to *SaxSpaCes* for alto saxophone and electroacoustic layer (2008–2009).

Ever since she geared her work towards combining electronic media with 'live instruments', she began to strive for the fullest possible integration and treating the instrumental parts on equal footing with electronic parts. In her hands, electronic media not only transform the instrument, but also 'extend' it, enhancing its sonic qualities, including those impossible to hear with traditional listening. The vast majority of the compositions in this group may be considered person-specific pieces. This is because Długosz creates his works considering not only instrument, but also the individual performer, who, according to the composer, must be characterised by a fully professional approach to composition and their own instrument, and at the same time an open, experimental one. What is atypical, the performers are involved in the piece from the very beginning of its

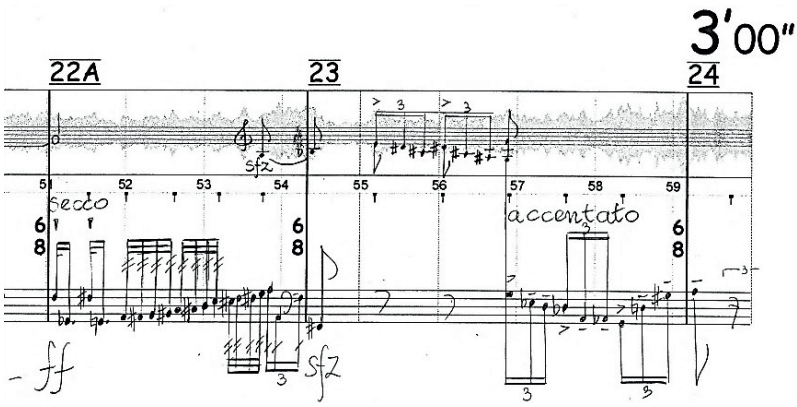
794 Długosz, commentary on the piece *TaBaMa…*, p. 71.

795 This is one of the most important features of the composer's aesthetic. For her, electronic means only serve as a tool to attain the artistic goals of the piece.

creation, as only 'active collaboration results in mutual stimulation on both sides and the joy of discovering uncommon, non-stereotypical means of expression on the way to creating new horizons of Beauty'.[796]

The substitution of the term 'tape' with 'electroacoustic layer' (or 'computer sound layer' in the case of *TaBar* and *Zakopane Lyrics*), which appears in the titles of the works, also carries a significance. It is not a matter of changing the medium from analogue to digital, but, rather, of separating oneself from the practice of passively playing music on tape, while at the same time emphasising that the material used in the music has its source in acoustic instruments. One of the many examples of this creative strategy is *A b a m u s* for cello and electroacoustic layer (2003–2004), inspired by the style of Andrzej Bauer. As the composer assures the audience, the electroacoustic layer material was produced exclusively from pre-recorded cello sounds – also performed by Bauer.

The several-minute piece consists of 12 short movements (*Sinfonia*, *Deciso*, *Intermezzo 1*, *Misterioso*, *Capricioso, Introduzione, Valse Mélancolique, Sospensione, Intermezzo 2, Dondolio, Teneramente* and *Finale*). They are joined *attacca*, and the cello and tape parts flow seamlessly from one to the other or intermingle. Frequent changes of pace are present, and the notated passages are a very precise fit alongside sections shaped ad libitum. This causes considerable difficulty in synchronising the two parts.

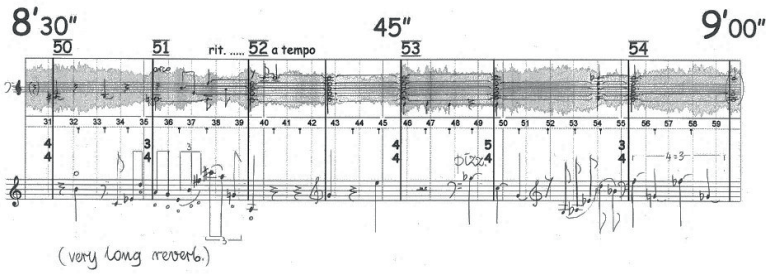


Example 42. *Abamus*, p. 5

796 Długosz, quoted in: Andrzej Rzymkowski, *Saksofon w wybranych utworach kompozytorów krakowskich początku XXI wieku [Saxophone in Selected Works by Kraków-based Composers at the Beginning of the 21st century]* (Kraków: Wydawnictwo Akademii Muzycznej w Krakowie, 2009), p. 74.

Długosz facilitates this by introducing an additional auxiliary track that reaches only the instrumentalist (via an earpiece). It includes a run of metric units in varying metres and at varying tempos, recorded with the composer's voice. The voice plays the role of a virtual conductor, as the composer did not measure time units mechanically, but by way of *rubato*, changing the intensity and articulation of the voice to suggest the narrative flow and direction of interpretation.[797]

Abamus constitutes highly abstract music with a clearly delineated expressive plan. The score contains numerous verbal additions, especially in the second, longest phase of the piece (*con vigore*, *agitato*, *impetuoso*, *con forza*, *accentato*, *con fuoco*, *feroce*, and *furioso*). Significant are also the dynamic (*sforzata*), expressive and articulatory contrasts. The cello part is busy, even nervous, at times 'crackling' and 'wheezing'. Respite is brought by the *Misterioso* (4′15″–5′(30)″) and *Valse Mélancolique* (7′15″–9′15″) and the final *cantabile* (11′00″–13′30″). The electroacoustic part also contains very varied and stratified material. Some of the layers act as a harmonic-sounding background (with a wide ambitus) or as a textural filling, while others come to the fore. Electronic media help Długosz to achieve a formal organicity, and, simultaneously, sonic and textural diversity. Here, the process of building the form is not based on a collagistic character, but on smoothly transitioning between phases. What remains unchanged in *Abamus* is the idea of playing with the sonic space and the juxtaposition of the 'live' cello with the virtualised cello summoned from the recording.



Example 43. *Abamus*, p. 15

797 An automatically-generated pulse (measured in seconds, known as the click), reaching the conductor through an earpiece, was used by the composer in *DesAkordaR* for accordion, 4 trombones, percussion and electroacoustic layer (2008).

The same happens in the later *Ombraggio* for violin and electroacoustic layer (2002–2003) as well as the *SaxSpaCes* for alto saxophone and the electroacoustic layer (2008–2009). Texturally, the tape parts play an important and equally-footed role to the respective instruments, imposing a particular sound climate on the whole. Overall, it is filled with filtered, spatialised, and time- or pan-extended bands of varying depth, which is achieved by adding a reverberation effect. Heavily transformed, filtered noises and murmurs foster an atmosphere of mystery, anxiety, or even dread. These effects leave everything shrouded in a thick 'noise fog'. Such unreal sounds affect the perception of time: its flow seems slower. The movement gradually dies down, the shreds of motifs and melodies in its sequence merging into one unbroken strand – a single, slow process.

3.2.3. In the space of sound interactions – pieces for modified or transformed instrument and tape[798]

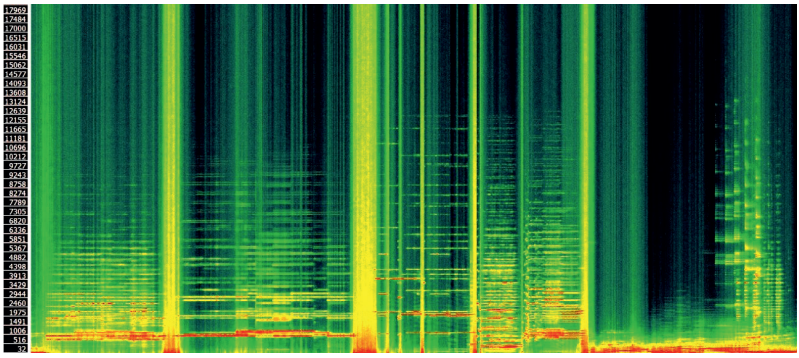
One of the most significant compositional problems tackled by Magdalena Długosz (apart from combining instrumental playing with a layer played from tape) is the problem of spatiality.

Already in *Spatial Arrangement* for a small orchestra and electronic devices (1980), her main objective was to process the sound and spatiality of live instruments. The orchestra was to be located not in the concert hall itself, but in the one immediately adjacent to it. A team of directors, located in the next room, was to carry out electronic modifications and panning on the sound material. The electronically processed sounds of the orchestra would reach the audience gathered in the concert hall through eight loudspeakers. In this way, the audience was meant to get the impression of interacting with an electroacoustic piece, while being aware that it was being performed and interpreted 'live' by the orchestra at the same time. Unfortunately, the piece was never performed.

In *Mictlan II* for accordion, digital reverberation device and tape (1988), the sound of the instrument was stretched across the stage space by changing the placement of the sound in the panning and reverberation effects. Thus, it is possible to create an illusion of the presence of not a single performer, but an accordion ensemble spread across the stage and even beyond. In the tape part, the composer emphasised the low frequencies, creating extended drone bands. As

798 Works with a 'modified instrument' are characterised by a much lower degree of transformation than those with a 'transformed instrument'.

a result, the sounds of the instrument became fuller, saturated, and dense, similar to the timbre of an organ or of synthetic sounds. These effects make the music both abstract and evocative at the same time, creating a mood that is mysterious, dark, and unsettling.



Example 44. A spectrogram showing textural changes in *Mictlan II* (6′00″–8′50″)

In *Mictlan II*, the composer wanted to minimise the typical dependence of the live-interpreted instrumental part on the fixed-time electroacoustic layer. This, in turn, was meant to enable a dialogue of sorts between these layers, modelled after a duet performance. Given the diversity of musical material in the different movements of the piece, she employed a different way for the instrumentalist to interact with the tape. In the first movement, the soloist's dialogue with the tape requires precise synchronisation, achieved by measuring time in seconds. In the second movement, composed as a solo quasi-virtuosic cadenza (enriched by live electronics), the problem of synchronisation is nonexistent – the tape is stopped. In the third movement, time is, once again, measured in seconds, but there is much more freedom. The musical material recorded on tape provides a backdrop of sorts for the instrumental part, which is improvised according to certain guidelines by the composer. It undergoes a live transformation with the use of a digital reverberation device. Thus the musical dialogue takes place between the soloist and the sound director.

Długosz found the recordings made during the preparation of *TaBaMa* so inspiring that they became a source of the sound material for a new piece, fully independent in character and form, *T a B a r* [799]

799 The title of the piece this time refers to Tadeusz Wielecki and Barbara Okoń-Makowska. *En passant* also refers to the Proto-Slavic word 'tabar' (borrowed from Persian), meaning 'axe'.

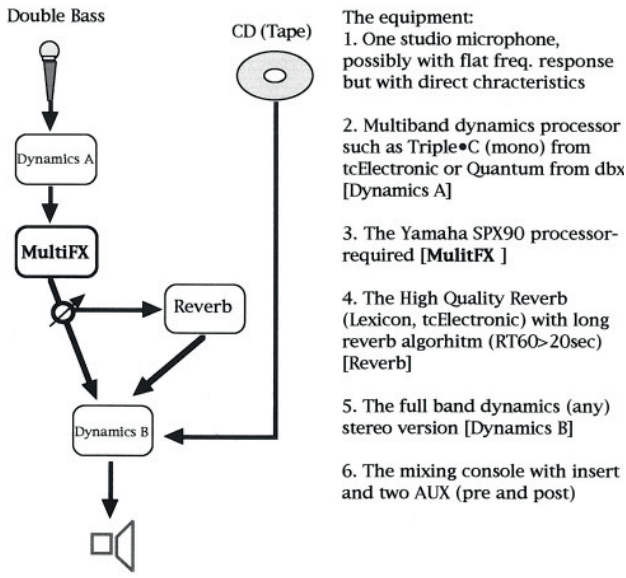
for an electronically transformed double bass and computer sound layer (1998–2000).[800] In this work, the spotlight is taken by the instrumental part interpreted live. She employed a number of innovative and original performance techniques. The double bass part is thus very varied – at times, emphatic and 'heavy', at others, 'thin' and shy. The articulatory devices include a variety of effects: *tremolando*, *glissando*, sounds of indeterminate or indefinable pitch, modulation by vertical movement of the bow, artificial harmonics, microtones, etc. The first phase is dominated by stretching sound bands, and the second by quasi-percussive effects such as a series of rhythmic strikes of the bow on the strings or sound box or *pizzicato* sequences. Furthermore, the double bass here is not a low-sounding instrument at all – instead, the instrument's extreme high registers dominate.[801]

Owing to amplification and live electronics measures, the sound of the acoustic double bass is powerfully transformed, making all articulations sound even more unusual. In fact, she precisely programmed 32 different sets of processing effects using a digital signal processor (Yamaha SPX90). These allow the instrument's sound to undergo various expansions during performance. The live electronics means in the foreground include spatial shaping (balance), repetition and reflection (delay and echo), control of reverberation parameters (reverb), 'chorus' multiplication effect (chorus), pitch change and pitch modulation (pitch change, flanger), etc. The texturally-stratified instrument part thus becomes a dense and complex structure. In the final phase of the piece, she used a sophisticated, colourful juxtaposition of multiplied high harmonics which, together with the sounds of the acoustic double bass, create a sound effect similar to an organ-based concoction.

As with most of her works, she has taken great care to score *TaBar* with great precision. The score legend provides detailed information on the devices implementing the live electronics measures, as well as how they are combined and set up.

800 The composition was first performed in November 2000, at a Polish Radio Experimental Studio concert at the Witold Lutosławski Concert Studio in Warsaw. The solo part was then performed – as it was two years later at the 'Warsaw Autumn' – by Tadeusz Wielecki, to whom the work is dedicated.

801 It is, incidentally, typical of Wielecki to play in a register that is extremely high for a double bass.

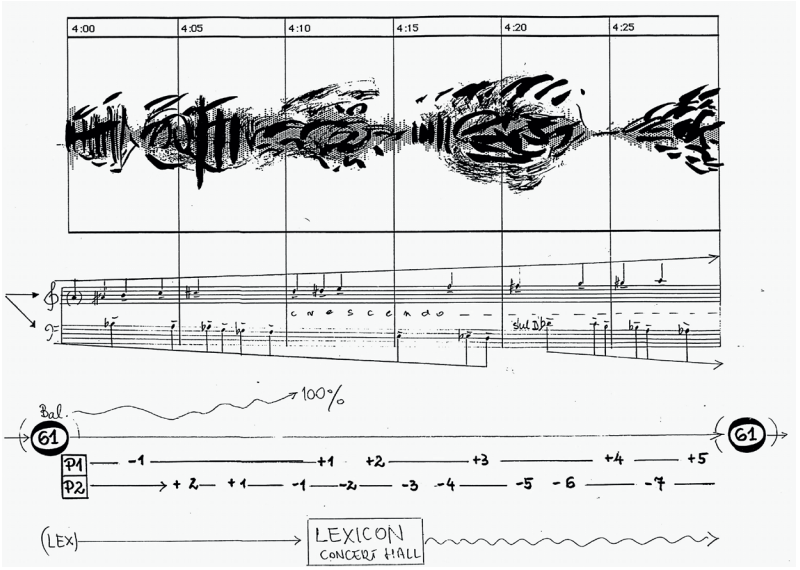


Example 45. *TaBar,* the method for connecting all media

In addition to the classical notation of the double bass part, the score contains a computer-generated graphic representation of the dynamics and energy of the electroacoustic layer (expressively deepened by her handwritten graphics) and precise instructions for the sound engineer (placed at the bottom of the page), who subjects the double bass parts to electronic transformations.

Much like in *TaBar*, the source material for the electroacoustic part in *Zakopane Lyrics* for electronically modified clarinet and computer sound layer (1999–2000)[802] are recordings – this time made in collaboration with a clarinetist, Wojciech Komsta. However, the two pieces differ in their handling of the solo instrument. In *TaBar*, the instrumental double bass part undergoes multifaceted electronic transformations over the course of the performance, while in *Zakopane Lyrics*, the sound of the clarinet undergoes only minor modifications through amplification and spatial 'deepening', achieved by smooth adjustment of the reverberation time and saturation. The electroacoustic layer is in an opposite kind relationship: in *TaBar*, it

802 There is also a second version of this piece for saxophone (2004).

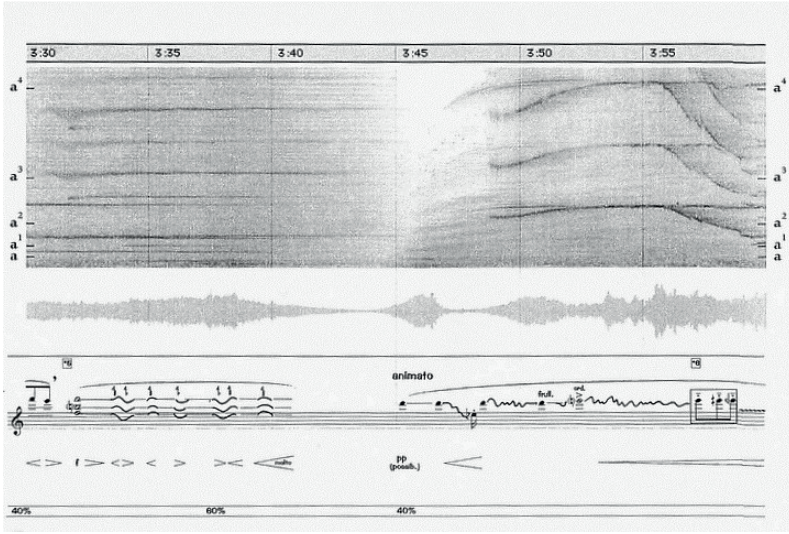


Example 46. *TaBar*, p. 9

primarily uses the natural sounds and timbres recorded by Wielecki, while in *Zakopane Lyrics*, the clarinet material is transformed to such an extent that its timbral specificity is blurred.

In *Zakopane Lyrics*, the palette of traditional instrumental sounds used both during the recording and in the live performance parts is expanded to include all kinds of innovative performance techniques: multiphonics, key strikes or blowing into the instrument in an airy, hissy manner without producing a full sound, whistling, *mormorando*, etc. At the end of the piece, the performer also makes sounds without an instrument, with their mouth alone. All this is done in order to achieve the richest possible sound material and, as is typically the case with Długosz, to serve the shaping of the musical narrative and expression.

In *Zakopane Lyrics*, the previously-recorded instrumental material was heavily transformed-deformed, even – using numerous effects: echo, reverb, resonator, inertia, stretch, grain, shuffler, chorus, harmoniser, flanger, filtering, pitch shift, and normalize. Initially, the piece is dominated by expanding, spacious sounds, with slow glissandos and trills. Here, the texture is outlined with clarity and transparency, and the sounds are more selective than in many of the composer's other works.



Example 47. *Zakopane Lyrics*, p. 9

One very important issue for her was the search for an adequate notation, graphically visualising the layer of the computer sound. On the one hand, it is intended to be evocative, and on the other, precise, so as to facilitate the synchronisation of the instrumental parts with the electroacoustic layer. Hence, the score of *Zakopane Lyrics* includes two ways of representing the electroacoustic layer: a spectrogram and a diagram showing its monophonised dynamics, and a computer score of the solo part with an indication of the intensity of the reverb modification.

Through sophisticated articulation techniques, the sound of the clarinet blends with the sound of the electroacoustic layer completely, at times making it difficult to distinguish between them. At the same time, she manages to achieve a state of permanent sound fluctuation – the transition of one sound form to another (a phenomenon that could be called sound morphing), and, simultaneously, a lack of clear formal segmentation. Thus the listener can receive the impression of simultaneous diversity and integrity. One might describe this impression – recalling the terminology of auditory scene theory – as the continuity of the auditory stream.[803]

803 See Chapter 2.4.

While *TaBar* and *Zakopane Lyrics* are characterised by a colourful abundance, *Silent Asphodels* for flutes, cello and electronics (2006) was, despite its sonic artistry, created using a relatively limited sound material and repertoire of means. The outlines of traditionally-shaped motifs, or melodies made up of sounds with determined pitches, may only be discerned incidentally in the instrumental parts; micro-intervals, harmonics and other sound effects see more frequent use. The cello abounds with a variety of 'swishes' and 'rustles'. Electronic means give all these sounds further emphasis.

In the works by Długosz, the instrumentalist collides with the processed versions of his recorded pre-compositional material during the performance. The concert setting thus becomes a space where real acoustics intersect with virtual acoustics. The fusion of these two planes takes place not only on the sound and form level, but also on another, higher one – semantic, aesthetic, or axiological, even. In the case of *Zakopane Lyrics* and *Silent Asphodels*, the key to reading the supra-musical meanings is the dedication and the – this time, non-acronymic – titles. The *Lyrics* were written for Anna Maciejasz-Kamińska, a composer associated with the electroacoustic studio of the Academy of Music in Krakow living in Zakopane.[804] *Silent Asphodels*, on the other hand, refer to the white flowers with narrow leaves and dense blossoms that can be found on Mediterranean coasts. According to Greek mythology, they grew in the subterranean land of the dead, in the local meadows by the River Styx. The piece is thus a kind of musical wreath laid on the grave of Józef Patkowski, who died in 2005.

3.2.4. From playback to interpretation – songs with an interactive computer sound part

A special place among the works by Magdalena Długosz is occupied by *Gemisatos* for orchestra, solo computer part, concertina percussion and live electronics. Here, the electroacoustic layer has been treated as a concertante solo instrument, with the performer elevated to the role of soloist-interpreter. The performer may utilise its individual segments, interact with the instrumental layer in correspondence, and freely shape the musical narrative of the entire piece.

804 Anna Maciejasz-Kamińska had an impact on the decision by Długosz to study composition.

The electroacoustic layer of *Gemisatos* is available to the performer as a multi-layer project, stratified texturally, and divided into 45 fully-composed segments. Selected strands and timbral figures are reproduced in horizontally-interlocking fragments. Placed at the beginning of the respective segments are phenomena that are strategically important for the synchronisation of all of the sound media. Their timely start ensures that the nodal points of the instrumental and electroacoustic parts, important in terms of form and narrative, are in line. To synchronise the segments, Długosz employed a special piece of computer software, Xini 1.4, written by Mateusz Bień and running in the Max/MSP environment. It is an essential tool for the *Gemisatos* solo computer part, allowing the management of inputs, dynamics, and spatiality of the pre-composed layers. Owing to the solutions employed in Xini, they can be freely entered (started) and then cancelled (muted). During the performance of the piece, the temporal flexibility of the electroacoustic layer thus obtained is able to consider the tempo variations. The solo computer part is produced during the concert (according to the score) by a 'creative sound director', whose status is as important as the concert percussionist and conductor. They should work with the latter two in order to shape the narrative, form, and expression of the piece. The interactive production of the electroacoustic layer brings to life the matter trapped in the pre-composed segments and permits performances that differ in interpretation.

The notation of the solo computer part was included in the score on lines with graphic representations of the dynamics and the pitch relationships between the successive segments (here, Długosz employed the comparisonics method,[805] allowing a colour-based representation of the frequency spectrum). On the line above the computer part, the score contains instructions for the performers handing the live electronics and controlling the dynamic proportions between the natural sound of the acoustic instruments of the orchestra, the sampler, the computer and percussion parts, as well as the modified instrumental sounds.

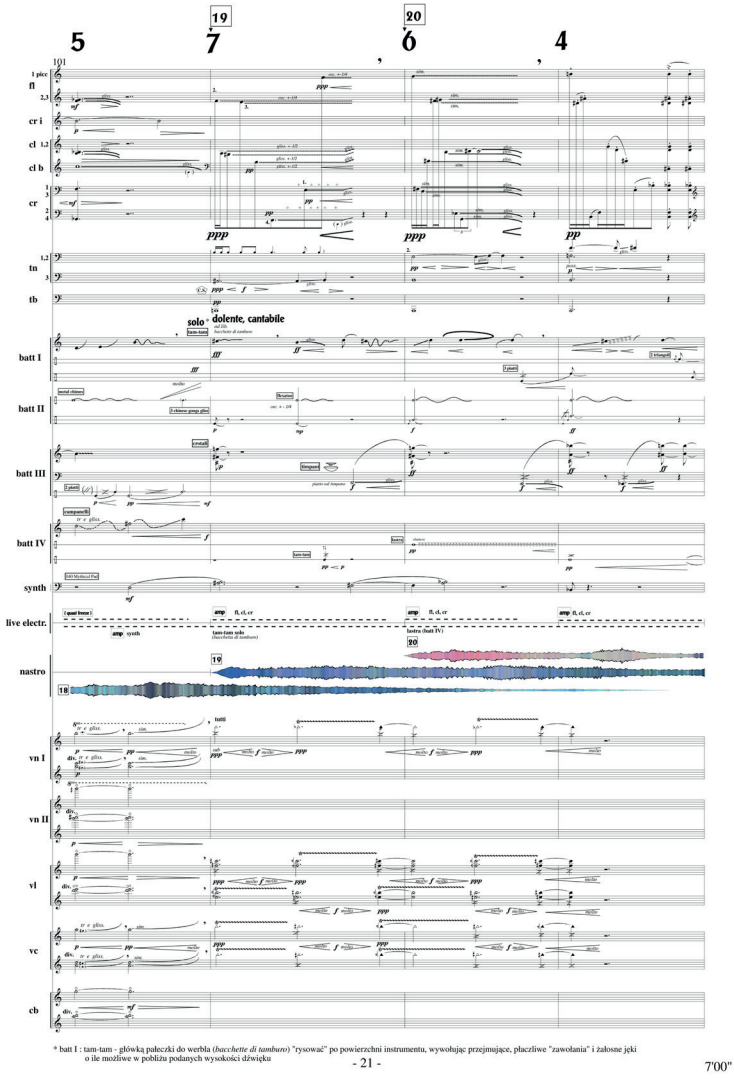
805 In a comparisonics chart, the dynamic chart (waveform) uses colours according to the active frequency band. Red corresponds to high frequencies, green and blue to medium frequencies, and dark grey to low frequencies. Such a graph is obtained by using a sound similarity measurement algorithm, created and developed at the University of Mississippi by Stephen V. Rice and Stephen M. Bailey.

Along with the score, she included a CD containing a recording of the studio-mixed solo computer part, being one of the possible executions, a model one time-wise. This recording may prove helpful as the performer, conductor, and sound engineers explore the solo computer part.

During the performance, the concertante percussion part is amplified, which allows the right dynamic proportions to be maintained in relation to the orchestra, also permitting the freedom to execute the spatial projection. Some instruments require pronounced amplification; this holds true of especially for the second movement of the piece (e.g. playing a flexatone using a bow, rubbing a tam-tam using a rubber ball or a snare drumstick).

In the instrumental sections called *Interferenza*, Długosz exploited the phenomenon of an acoustic beat by using micro-intervals and consonances, smoothly oscillating around the unison and octave in the parts of selected instruments. The resulting effect of sonic jitter and sound vibration is further emphasised by amplification. The use of electronic freeze and reverb effects to modify instrumental parts, on the other hand, results in giving one the impression of blurring the clarity of the sonic contours, stopping time, or sound 'freezing' of sorts. The concluding *Registrare* segment, whose musical material is a recording of the last orchestral fragment of the work recorded during the rehearsal, works in parallel with the orchestral part. It was electronically modified and then incorporated into a solo electroacoustic part.

The sound space is also extended by electronic effects, which is enabled by an opportunely-positioned system of at least six loudspeakers – around and above the listeners. The spatial projection is not described in the score, as it is largely dependent on the technical and acoustic conditions of the concert space. However, according to the composer's intent, the performance should be accompanied by the sensation of a gradual widening of the sound space in the concert hall: by the successive filling of the centre in the first movement, complementing the depth in the second, and then launching the vertically-extended (periphonic) projection thanks to the loudspeakers placed under the ceiling in the third. Thus, an important task for the interpreter of a solo computer part (in consultation with those operating the live electronics) is to propose their own concept of shaping spatiality, taking into consideration the acoustic and architectural conditions of the concert hall where the performance is to take place.



Example 48. *Gemisatos*, p. 21

In 2009, the *Gemisatos* represented Polish music at the International Rostrum of Composers in Paris, where it received a prestigious recommendation. This has resulted in the piece being broadcast on the world's radio stations and on the European Radio Union network multiple times.[806] Commenting on the success of this

806 Długosz, *Summary of professional accomplishments…*

composition, Andrzej Chłopecki described it as 'a kind of completely innovative *concerto grosso*', and as 'a sound painting of extraordinary suggestiveness'.[807] The Paris Rostrum considered the piece to be 'the most technologically advanced of all the offerings, although it was undoubtedly not the technology itself, but, above everything else, the aesthetic shape of the piece that determined its very high score'.[808]

The word 'gemisatos', as the composer explains, does not function in any language and has no meaning in a literal sense; it is a code, clear and intelligible only to the composer herself. The neologism was crafted so that its components, which are also the subtitles of the various parts of the work, overlap with one another. This is reflected on a musical level, where, for example, the individual sequences of the solo computer part build up and overlap with one another, and the three main parts of the piece (in the textual and ideological sense) overlap in an elisional manner so as to form a complete formal shape: part I is Gemi, part II is Misa, and part III is SATOS.[809] Thus, the title of the piece conceals extra-musical meanings. These, however, are not revealed by her either in the commentary or in her statements. Whatever hides beneath the surface of musically abstracted emotions is to remain a mystery to the listener.

The solution to the problem of the synchronicity applied in the solo computer part of *Gemisatos* made it possible to use the experience gained in later works, while the idea of performance interpretation found its development in the electroacoustic composition *BisAkordaR* (2010). In her commentary, she reveals that she was aiming to address the problem of interpretation when it came to a particular area of musical creation – 'music for tape', which, in a concert setting, is generally perceived to be subject only to reproduction:

> How does one bring to life a sophisticated electroacoustic matter carefully refined sonically in its multiple aspects, composed with precision in a painstaking creative process, and trapped in the form of a recording? How does one enable its artistic interpretation during a concert performance? To whom should one entrust such a subtle and entirely new task? The sound engineer? The sound director? The instrumental part performers? Or perhaps the composer?[810]

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807 Andrzej Chłopecki, *Raport z Paryża. Międzynarodowa Trybuna Kompozytorów 2009 [Report from Paris. International Rostrum of Composers 2009], Ruch Muzyczny*, 2009, issues 16–17, pp. 7–8.

808 Chłopecki, *Raport z Paryża…*, pp. 7–8.

809 Długosz, *Summary of professional accomplishments…*

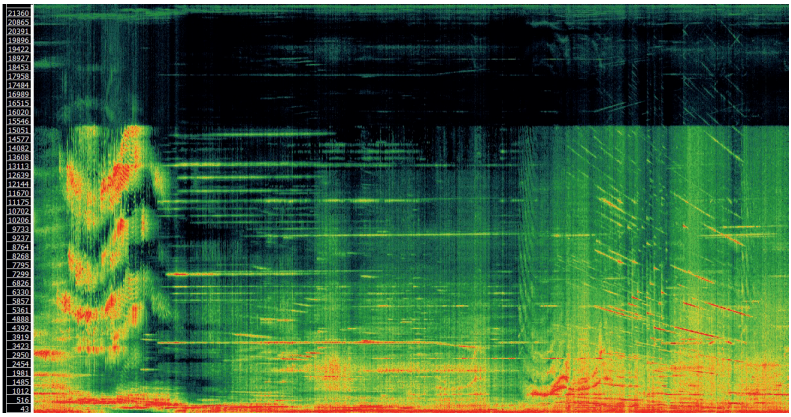
810 Długosz, commentary on the piece *BisAkordaR* (composer's materials).

In *BisAkordaR*, the listener receives a definitive answer. The score is a graphic representation of electroacoustic material composed in five layers (not unlike the instrumental groups in a classical orchestral score). Each layer – a register voice of sorts – contains a collection of composed, multi-faceted musical qualities (segments) that the performer interprets in terms of timbre, timing and space.



Example 49. *BisAkordaR*, score – a holistic view

The audio material is fed into the computer. Using the Xini software (used in *Gemisatos*), the performer, maintaining the narrative planned by the composer, is able to run each segment independently, and to introduce minor modifications as well – to brighten or darken the sound, change dynamic proportions, direct sounds to any of the speakers, etc. The sound matter of the segments was completely dominated by sounds of indeterminate pitch and noise character, rising and fading seamlessly. Some are jittery, with strong dynamic fluctuation (cf. Example 49), others are continuous and stable bands, concentrated around a few frequencies, others feature oscillation and glissandos (cf. Example 50). The entire narrative of the piece plays out around these few abstract sonic qualities – continuity and jitter, stability, and shifting in the harmonic spectrum.



Example 50. *BisAkordaR*, spectrogram, 3′50″–4′50″, dynamically fluctuating and frequency oscillating noises (left); bands concentrated around several frequencies, stable (middle) and glissando sonic smears (right)

The Xini 1.4 software, therefore, enables the sound director to create a performance interpretation in full, just as is the case with instrumental music. All of the compositional strategies serving this idea are carried out through interaction with virtual sound media. One may perceive a similarity with DJ practices, where fragments of different songs are merged through various electronic devices into a single, synchronous whole.

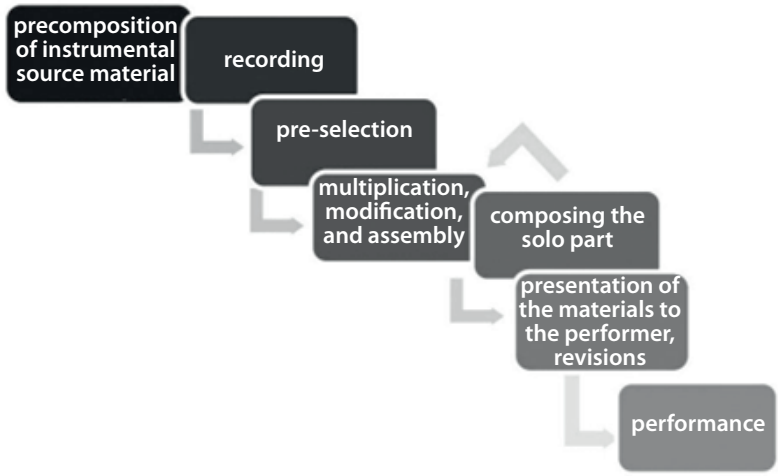
In summary, in *BisAkordaR*, the composer exhibits an innovative understanding of the performance of purely electroacoustic music, which has progressed from tape playback to live interpretation. There is, therefore a need to develop a new type of performer who, just like the soloist-instrumentalist, would be able to creatively interpret the composed electroacoustic material. Długosz intends to develop the synchronisation methods employed in the *Gemisatos* and *BisAkordaR* subsequent electroacoustic compositions. This strategy aims to extend acousmatic music with a hint of instrumental expression and interpretive possibility. Both constitute great examples of electroacoustic hypertext.

*

The works by Magdalena Długosz fit into the poetics of *musique concrète* and acousmatics, but the material in most of her works are being narrowed down to instrumental sounds. This radically changes the traditional creative process. The composer's activities include the preparation of pre-compositional instrumental materials for

recording, their recording (carried out in close creative collaboration with the performer, with higher artistic and aesthetic goals in mind, already present at this stage), the selection and modification of the recorded material, the composition and editing of the selected sound objects with simultaneous composition of a solo instrumental part (oftentimes with the use of a sampler), the presentation of this part to the performer with potential corrections, and, finally, the premiere performance. At each stage, Długosz employs a variety of new media.

Recording the sounds using sophisticated techniques employing microphones of varying characteristics and directionalities (e.g. condenser, contact), as well as electroacoustic amplification, allows the recording of sounds that are not audible in a traditional stage setting. Here, the microphone acts as an acoustic magnifying glass of sorts, permitting one to perceive the hitherto-imperceptible traits of the sound – what may have been hidden, but valuable from a sonoristic point of view.



Example 51. A schematic representation of the process of creating a piece for instrument and electroacoustic layer

For Długosz, the musical value overarching all other means is the tone – the timbre, coloration, density and 'consistency'. This applies to both the electroacoustic and instrumental layers. One would be hard-pushed to look for, say, a system of sounds here – the material is shaped intuitively and the sounds are, to a large extent, treated merely as a vehicle for sound. One might even get the impression that the composer constantly prevents the instrumentalist from employing

traditional performance techniques in order to make the sounds achieved while playing 'live' better correspond to those emitted by the loudspeakers. Sometimes, a paradoxical situation transpires, with the sound of the tape seemingly more natural than those obtained while playing the actual instruments. The composer achieves this effect by often using almost exclusively material recorded by the same instrumentalist who interacts with the tape during the performance in the tape part itself. In the works by Długosz, therefore, the boundary between natural, processed, and artificial sound, i.e. that created live and that emitted from a loudspeaker, is blurred. The world of real sonority merges with that of virtual acoustics.

The acoustic illusions have an even stronger effect during a concert performance, when one sees the instrumentalist interacting with the electronic parts. These two musical planes overlap, accompanying and interpenetrating each other, dialoguing or arguing (the sound image does not always harmonise with the gestures by the performer). At times, the instrumentalist engages in a dialogue with themselves of sorts – what appears in the electroacoustic layer is a media-mediated reflection of the sounds of the instrument. The timbral nuances of this peculiar soliloquy would not have been possible without modern electronics and the computer software controlling them.

In pieces for electronically modified or transformed instrument and electroacoustic layer, a kind of double mediation of instrumental sound through electronic media occurs – both at the stage of pre-composition recordings and at that of completing the sound material, as well as at the stage of live electronics modification during the performance. In such cases, natural (acoustic) sounds coexist with their augmented and mediatised equivalents in a single piece. At the same time, the boundaries between the solo part, its live processing and the electroacoustic layer prepared in advance become blurred. This approach to shaping the sound matter ensures sufficient timbral variety while maintaining the coherence and logic of the overall form. The sonic qualities of the electroacoustic layer depend directly on the instrument that co-creates it, and constitute an ampliation and 'extension' of its capabilities. This makes it possible to achieve an agreement between the electronic media and the instruments on a musical level, fulfilling the aesthetic goals intended by Długosz. For the same reason, the respective pieces for the different line-ups are characterised by an entirely different tape sound (*Abamus* and *TaBar* are – to put it in general terms – rougher and sharper in sound than *Mictlan II* or *Silent Asphodels*). Indeed, the piece is intended to express

the nature of the sound medium itself, to 'recount' the sound of the instrument chosen by the composer to convey her musical idea. The sounds thus integrate at the level of the source material, but also on a higher, semantic plane.

When working in the studio, Magdalena Długosz employs cutting-edge solutions when it comes to sound composition and direction; she aids her work with ProTools, Samplitude, GRM Tools and Max/MSP. These media primarily enrich the compositional toolkit with textural, timbral, spatial, and, by consequence, expressive means. Using electronic means, Długosz aims to:

> Broaden the sonic and colouristic aura of the work, giving the electroacoustic layer the characteristics of an equal actor, as is the case in chamber or orchestral music. Owing to modern technology, the sound quality of the sound emitted through electronic equipment is now able to match that of an acoustic instrument, and one can afford to compose close relationships on a timbral level. The kind of sound I get from hours of experimentation with computer software cannot be achieved from instruments in real time. It is possible to attempt live transformations during a concert performance, but not with the complexity and composition involved here. This leaves painstaking work in the studio as the only option.[811]

The repertoire of live electronics employed by the composer ranges from the addition of ready-made effects to detailed sound deconstruction and sonic resynthesis (additive, granular and fractal). These modifications go so far as to entirely obliterate the auditory associations with the source material while retaining its natural, instrumental expression.

As noted by Ewa Szczecińska, the works by Długosz are characterised by 'moderation, harmony, total control over timbral nuances and detail', and their execution is an attempt to 'build an ideal world'.[812] In building this world, her main focus is that of shaping the sound. One might even speak of a timbral hypersensitivity, in the positive sense of this expression, which places the works by Długosz within the realm of electroacoustic post(meta-?)sonorism.

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811 Długosz, quoted in: Adamek, *Materiał instrumentalny…*, p. 106.

812 Ewa Szczecińska, *Górą pięćdziesięciolatkowie! [Pentagenarians Win!]*, *Tygodnik Powszechny*, 26/06/2005, https://www.tygodnikpowszechny.pl/gora-piecdziesieciolatkowie-125803, http://www.polmic.pl/images/stories/docum/TP-Gora_%20piecdziesieciolatkowie.pdf.

In her work, the composer also addresses the issue of recording and synchronising the part played and performed live. Each score constitutes a different, successively refined proposal. Both computer editors and hand notation are used here. Sometimes, above traditional notation, she places a waveform-type dynamic-energy diagram, extending it to include a graphic representation of the material contained in the electroacoustic layer (*TaBar*), or a note-based score of the characteristic melodic motifs and rhythmic structures (*Abamus*, *Ombraggio*), or a comparisonics-type chart (*Gemisatos*, *SaxSpaCes*,[813] *BisAkordaR*). This is intended to facilitate the instrumentalist's orientation and, according to the composer, to stimulate their imagination and encourage lively interaction with the electroacoustic layer. She uses dynamic and spectrographic visualisation (*Zakopane Lyrics*) not just for informative purposes, but also for aesthetics: 'I believe that richly detailed, sophisticated, and beautiful notation inspires performers to make beautiful music,'[814] she says.

The wealth of resources offered by the unlimited potential of audio-transformation programmes makes it possible to make all other elements dependent on timbre, even the form itself. Indeed, the composer reasons in terms of a timbral narrative of sorts. Its shaping is not based on traditional musical elements – one would be hard pushed to find melodic relationships or distinct rhythms in this music. The predominant sounds here are of undefined pitch, noisy, quasi-percussive, or modelled by fluctuations and peculiar harmonic modulations and transpositions. The formal progression juxtaposes slightly modified sounds that carry a perceptible reference to the acoustic sound of the instrument with synthetic sounds, typical of electronic music. The textural formation and the single sound figure in an electroacoustic part may sometimes be made up of a dozen files and sound samples. Owing to electroacoustic multiplications, the texture of the piece is significantly expanded and thickened. The pre-recorded sounds are transformed into short, impulse-type sounds (although one could hardly speak of a sense of regular pulse or metre here), but also into extended sonic bands.

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813 In *SaxSpaCes* for alto saxophone and electroacoustic layer (2009), the spectrogram of the electroacoustic layer even became an additional, visual element of the performance. This was the only attempt thus far, but not the last – promises the composer – to combine musical performance media with visuals created on the basis of the spectrum.

814 From a conversation with the composer, 11/2014.

Works by Długosz are musical landscapes painted with tones that are sometimes subtle and crayon-like, sometimes exaggerated. The sound drawing of these landscapes is devoid of sharp edges, the with colours merging and overlapping to create ever newer shades. The melodic structures and rhythm groupings often remain indistinct, and tend to resemble – again, in not unlike in a painting – lines (wavy, straight, thin, thick), dots, spots, bands. Sometimes, it is possible to distinguish a background and a figure plan, and sometimes the whole piece is one continuous, shimmering, multicoloured band, fluently changing its musical shades. The form is thus a sonorous continuum of finely-woven textures, built on the model of works by sonorists, and the handling of tensions becomes a process. The unconditional continuity in the pursuit of an ever-wandering goal is achieved through local climaxes. Momentary expressive tensions combine smooth transitions from rough to subtle, from jittery to stabilised sounds. 'The moments of relaxation,' writes the composer, 'are achieved through states of apparent stability, the illusion of catching up with the goal, of discovering its mystery, so that the tension may escalate again with full force, going on and on into the unknown heights.'[815]

Długosz aims to induce in the listener a state of acoustic immersion, prompting greater emotional involvement. She considers the quadrophonic or octophonic spatialisation of her stereophonic works to be an important part of interpretation. As early as 1995, she was experimenting with the Gmebaphon multi-channel speaker system by spatially interpreting her stereo *Lenyon* for tape (1994–1995). *Océan Cité* (*Ocean of the City*) for the French ballet project Pierre Deloche (2007) was, in turn, premiered through an 8-channel outdoor sound projection. *Beyond Silence* (2007–2008), another, also octophonic electroacoustic composition, was produced by Długosz in the studio of the French IMEB. At the premiere of the work at the Synthèse Festival (2009) in the Maison de la Culture Concert Hall, the composer presented her own spatial interpretation of the work, using the Cybernéphone live spatial diffusion system made up of over a hundred loudspeakers.

Parameters such as spatiality and dynamics are left to interpretation by the composer, but she does not permit free improvisation. Her aesthetic attitude prompts her to take total responsibility for the final timbral product during a piece's performance. Długosz finds live electronics techniques risky, and their structure so underdetermined

815 Quoted in: Rzymkowski, *Saksofon w wybranych utworach…*, p. 74.

that in many works she limits them or abandons them altogether. She also says that live electronics are not able to produce the same sonically complex and multi-layered results as when working in the studio, where one has everything 'right in front' all the time – after all, one is able to check and refine the final result at any given time.

Długosz gives her works intriguing, sometimes puzzling, sometimes poetic titles that may imply the extra-musical content of the work for the listener. They are meant to 'tune' the listener into the right attitude, and may also be the key to reading the music:

> The title is (…) something extremely important, (…) a kind of magical key, allowing one to get closer to the essence of a given composition, pointing to its concept, message, and perhaps even revealing a shred of mystery. (…) In electroacoustic music, this problem assumes particular importance. I try to make sure that the word used and its sound remain closely related to the idea and circumstances of the creation.[816]

This is the case with *Zakopane Lyrics*, *Silent Asphodels*, *Beyond Silence*, and *DesAkordaR*. Sometimes, the titles are acronyms, referring to instruments (*SaxSpaCes*, *SaxSpiro*, *SaxInSpiro*) or people associated with the piece (*PatJan*, *TaBaMa*, *TaBar*, *Abamus*, *BisAkordaR*).

The composer attaches great importance to the search for and selection of performers, as well as having a close artistic relationship with the musician for whom she writes and with whom she collaborates at every stage of the work's creation. This enables the transfer of many of the characteristics of instrumental music – and 'instrumentality' itself – into the realm of multimedia. Electroacoustic 'widening' and 'extension' of instruments is a search for the perfect musical medium with universal expression. Indeed, it is expression that is the plane unifying all other formal elements, such as the abstraction of sound, the complication of texture, the space play, or the possibility of interactive execution of the electroacoustic parts. The importance of expressive power may be seen, for example, in the abundance of expression- and performance-related terms used by Długosz.

The synergistic interplay between acoustic and electronic means may evoke in the listener a sense of a hidden, extra-musical programme that may have presumably accompanied the composer at the time of the work's creation. However, Długosz only implies its

816 *Z Magdaleną Długosz rozmawia Małgorzata Pawłowska [Magdalena Długosz interviewed by Małgorzata Pawłowska]* [in:] *Jubinalia. Krakowscy kompozytorzy – ku nowej harmonii [Jubinalia. Kraków Composers – Towards a New Harmony]* (Kraków: Akademia Muzyczna w Krakowie), 2012.

presence in a veiled way, as she wants her music to enchant listeners with its very sound, emotions and – more importantly – not to lose the value of purely musical beauty, so often eliminated by contemporary electroacoustics, while still remaining abstract.

3.3. The quest for the impossible instrument – the performances and live electronics works by Cezary Duchnowski

One of the main representatives of the live electronics current in Polish music is Cezary Duchnowski, composer and pianist-improviser (born in 1971). Ever since his studies under Leszek Wisłocki, he has been permanently affiliated with the Academy of Music in Wrocław[817] and its Computer Composition Studio. Duchnowski also chaired the Wrocław branch of the Polish Composers' Union, establishing the Musica Electronica Nova Festival – one of Poland's few entirely devoted to electroacoustic works. As of present, he teaches, among other things, computer music production[818] at his alma mater.

This is the kind of work Duchnowski is completely absorbed in as a composer – almost every piece he composed after 2000 features electronics (*Beginning*, 2001; *Progress*, 2001; *The Aim. Broadcast 2*, 2002; *Triads*, 2002; *Reality on Stretched Braces from the Window*, 2004) or a computer (*Wyczochraczone*, 2002; *Dishevelled Grass*, 2002; the *monads* cycle; *Non-Highrisers*, 2004; *The Gate*, 2005). The works by Duchnowski include programming work (primarily in the Max/MSP environment), allowing him to create new compositional and performance tools in the form of patchers, which act as virtual instruments of sorts in his works.

The creator almost always combines new musical media with traditional instrumentation. He is far less interested in encapsulating musical content on 'tape', the few examples including *Hypér tes morphés* for tape from 1998 and *Ovinu Malkeinu* for tape from 2000.

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817 Duchnowski has held scholarships from the Heinrich-Strobel-Stiftung des SWR in Freiburg, the Friends of the 'Warsaw Autumn' Foundation, the AUKSO Music Foundation and the Ernst von Siemens Musikstiftung in Munich. In 1995, he graduated from the Postgraduate Music Therapy Programme.

818 Duchnowski is the author of the teaching script *Programowanie obiektowe w multimediach. Środowisko MaxMSP firmy Cycling74 [Object Oriented Programming in Multimedia. The MaxMSP Environment by Cycling74]* (Warszawa: Uniwersytet Muzyczny Fryderyka Chopina) [s.a.], http://www.medialarts.pl/download/skrypty/Programowanieobiektowe-w-multimediach.pdf.

In the case of works featuring instruments, too, the electroacoustic layer is not a pre-assembled static recording, but, rather, it is created on the fly during the performance; in other words, as a result of the processing, the instrumental part becomes an automated, yet 'live' electroacoustic accompaniment.

Live electronics works have become a trademark of Duchnowski, in a certain sense. Within its framework, the composer creates virtual instruments that may be 'played' via a computer, producing pre-structured algorithmic textures and sounds. In interviews, the composer admits his particular fondness for activities that create a tension between the composed and the improvised, and between determinism and freedom. In addition to 'pure' electroacoustic music, Duchnowski also has a keen interest in theatre, performance and the visual arts – in the broadest sense of the term – employing interactive media.

3.3.1. From reinterpretation to improvisation – transcriptions and performance practice

A separate strand of Duchnowski's work is formed by reinterpretations and transcriptions of music by other composers created using new media. The underlying intent of these projects is not merely to imitate the original instruments using computer simulation, but 'to find a way of rendering the creator's intention faithfully, sometimes even more faithfully than in the original, using means that were not available at the time a given work was created.'[819] Duchnowski, therefore, wants the ideas contained in the works of the past to be expressed in the language and media of our time. The creator believes that:

> The contemporary listener, boasting more experience with new means of expression, perceives old compositions as a heritage park of sorts – quite differently from one who was alive at the time when the work was created. Indeed, had this instrument existed in his time, one may not be certain if Bach would not have entrusted *Das wohltemperierte Klavier* to the piano.[820]

Among these electroacoustic reinterpretations are works by:

819 Cezary Duchnowski, *Summary of professional accomplishments*, 2013, https://www.amuz.krakow.pl/habilitacje/postepowania-habilitacyjne/cezary-duchnowski/.

820 Duchnowski, *Summary of professional accomplishments*

— Johann Sebastian Bach (*Suite in D minor* for cello and computer, produced as part of the Trans-Fusion project, 2002[821]),
— Karol Szymanowski (*Szymanki kurpiowskie*, 2007[822]),
— Frederic Chopin (*Chopin Around* performed during the *Chopin and his Europe* Festival, 2010),
— Olivier Messiaen (*Louange a l'immortalité de Jésus* for solo cello and electronic layer, 2011),
— Kazimierz Serocki (*Pianophonie* – replacing multiple processing analogue devices with a single digital computer system, 2012),
— Witold Lutosławski (*El-Derwid. Stains on the Sun* – a study of popular songs created by Lutosławski under the pseudonym Derwid, CD released in 2013).

Duchnowski creates these transcriptions together with other artists and composers, most notably with Andrzej Bauer, Agata Zubel and Paweł Hendrich. They fit in with the general characteristics of Duchnowski's work – a desire to search for new, sublime sounds and new, stronger expression, achieved through the unconventional use of cutting-edge digital technology in combination with traditional instruments.

The current of reinterpretation is closely linked to a part of Duchnowski's artistic activity that is no less important, which is to say, musical performance. He has a particular fondness for *improvisional* music, which he expresses in numerous collective initiatives; he collaborates with people like jazz musicians, performers, and other improvisers. He is a pioneer of the original human-electronics current, which involves controlling 'playing' computer systems – virtual instruments – through improvisation on acoustic instruments. As part of this new trend, in 2007, Duchnowski (prepared piano + computer), together with Paweł Hendrich (electric guitar + computer) and Sławomir Kupczak (violin + computer), founded the improvising trio Phonos ek Mechanes, whose concerts take on the characteristics

821 Audiovisual documentation: http://www.polskieradio.pl/8/192/Artykul/841200,TransFuzja-elektroniczne-zabawy-z-Bachem.

822 'We have the ambition,' writes the composer, 'to remain faithful to the intentions of the author of the song, although we want to speak the language of our peers. "True folksiness" – that flowing, indeed, from our roots – is a source of cosmic inspiration and a dreamlike pretext for personal and contemporary artistic expression. This is how we understand Szymanowski's attitude, this is how we understand "folksiness", as an expression of organic intentions, flowing from areas that are deeper than our interiors'; http://www.duchnowski.pl/english/noty.html.

of electroacoustic performances close to the noise style. Musicians often prepare or tune their instruments microtonically, though the sounds produced by them are not heard by the audience directly. This is due to the fact that, first, they are fed into computers, which radically transform their sound. The sound parameters recorded by the microphones and then digitised – pitch, volume, duration, timbre – may be transformed into entirely new sound qualities. Thus the instrument becomes a physical controller – a data interface, while the computer (together with the programs created in the Max/MSP environment) becomes a virtual instrument – a sound interface. As a result of these radical transformations, the listener perceives a sound effect that is completely different – one that does not resemble the original instrumental sounds at all. And, even though it is the man rather than the machine who is the main creator controlling the course of musical events, their gestures and the way they play do not always correspond to the sonic results perceived by the audience.

An essential element of the performative concerts by Phonos ek Mechanes' is a collective and spontaneous improvisation. Before the performance, the artists only define the formal skeleton of the music; the concretisation of the sound content is born in real time, by way of creative interaction. The improvisation elements do not get in the way of reinterpreting music from the past. In 2008, commissioned by the Ad Libitum Festival, the members of the ensemble turned to graphic scores by Roman Haubenstock-Ramati. For this project, the members wrote special computer software that transformed the music played directly according to the graphics left by the composer.

Given that, as early as in his very first compositions, Duchnowski exhibited an interest in the human voice as an instrument with the broadest expressive possibilities, he began an ongoing collaboration with the composer and vocalist Agata Zubel, with whom he forms the composition and performance duo ElettroVoce.[823] Their activities focus on expanding the performative possibilities of the human voice, while at the same time questing for a primal, universal timbre. This manifests in a variety of their own and other people's projects. In

823 The duo has performed at numerous contemporary music festivals in Poland and abroad alike. The songs performed by them (oftentimes, their own compositions) have been repeatedly recorded and presented by radio and television stations. In April 2005, they received a special prize for the best ensemble with electronics at the prestigious 'Gaudeamus' contemporary music performance competition, held in the Netherlands. One of the albums was nominated for the Polish Fryderyk Awards 2008, as one of the best recordings of Polish contemporary music. See: http://www.elettrovoce.com/.

2005, they contributed to the *Szymborskie Improwizacje* for voice, piano and computer – an Italian-Polish project of improvised music inspired by the poetry of Wisława Szymborska.

Duchnowski's artistic activities often transcend sound art, as exemplified by his numerous interdisciplinary projects, as well as his music for films and theatre performances. As early as 1997, together with a composer, Marcin Rupociński, he founded the group Morphai, creating multimedia performances involving artists from various fields of art.

Duchnowski is also involved in initiatives by other composers, such as Rafał Augustyn's Double Exposure project in Wrocław, aiming to organise concerts during which individual compositions are combined into a coherent performance using a specially prepared scenario. In the words of Dorota Szwarcman:

> The artistic groups he co-founded are not like traditional chamber ensembles in which everyone simply plays their part. It is always a team of people who work closely together (this, of course, should be the ideal pursued by every chamber ensemble, but, as we know, ideals do not always have the opportunity to come true), and whose performance is also dependent on this cooperation.[824]

The interactions occurring within such activities are supposed to produce a new musical entity which, following Pierre Lévy, could be called 'collective intelligence'.[825]

3.3.2. Electroacoustic deconstructions – works for voice, instruments and computer

One representative example of creativity and performance using live electronics means is Duchnowski's series of works with titles featuring the word 'monad'.[826] Many of the parts of the cycle composed thus far have been performed at major festivals, and not only in Poland, where they have met with lively interest from music critics[827] – more than

824 Dorota Szwarcman, *Muzyka 2.1: Cezary Duchnowski [Music 2.1: Cezary Duchnowski]*, http://www.dwutygodnik.com/artykul/3905-muzyka-21-cezary-duchnowski.html.

825 See: Pierre Lévy, *Collective Intelligence: Mankind's Emerging Word in Cyberspace* (New York: Helix Books, York 1994).

826 Duchnowski writes this word in the title with a lowercase letter intentionally.

827 *monad 2* was performed at the 'Warsaw Autumn' in 2003, and *monad 3* in 2004. The latter piece won first prize at the 10th International Rostrum of Electroacoustic Music in Rome in May 2004.

anything else, as a testament of the wide-ranging possibilities when it comes to interaction of the human voice and traditional musical instruments with real-time processing electronics.

The first piece in the series was written for traditional instrumentation: accordion and two violins (2001).[828] Duchnowski's subsequent monads were composed with the consideration of electronics, tasked with transforming the instrumental parts live. *Monad 2* is for voice and trumpet, *monad 3* for voice and piano, *monad 4* for clarinet and trumpet, and *monad 5* for a minimum of three improvising musicians – all with a computer.

The *m o n a d s* are an attempt at finding for new musical qualities at the level of the basic components of a piece. In the words of Duchnowski himself:

> It made me question whether composing new music for old instruments made any sense at all. I have come to the conclusion that composing in the true sense means shaping the elementary particles of music.[829]

In his commentary on the *monads*, he adds:

> This entails the necessity of a deeper intervention in the sound matter. Hence the use of the computer – an instrument whose open potential is of great help when it comes to finding a new facet of the elemental qualities of music, unencumbered by the weight of extra-musical content. In addition to composing sounds over a specific space-time, the instruments themselves can be 'composed' here as well. This situation allows one to commune with the essence of music. It allows one to shape its starting point and, at the same time, the *conditio sine qua non* – a timbre that is in itself individual. It is the inseparable substance of which a musical entity is composed; it is – not unlike Leibniz's monad – a closed cosmos.[830]

828 A year later, the composer developed a second version, using a harpsichord instead of an accordion. Due to the absence of electronic media, this piece will not be discussed in the present text.

829 Duchnowski, *Summary of professional accomplishments*, p. 7.

830 Duchnowski, commentary on the piece *monad 3* [in:] *Warszawska Jesień '04. 47. Międzynarodowy Festiwal Muzyki Współczesnej, 17–25 września 2004 [Warsaw Autumn '04. 47th International Festival of Contemporary Music, 17–25 September 2004]*, [programme book], p. 51.

This 'instrument composition' and 'substance of musical being' would not be attainable without the use of modern electronics, sound equipment, and specially designed, advanced computer software written in the Max/MSP environment for processing the amplified instrumental parts during a performance while creating the electroacoustic layer of the piece. These activities always bear a hint of improvisation and imprecision, and the final shape of the electroacoustic layer is largely dependent on the performer interpreting the vocal or instrumental part, and sounding slightly different in each performance.

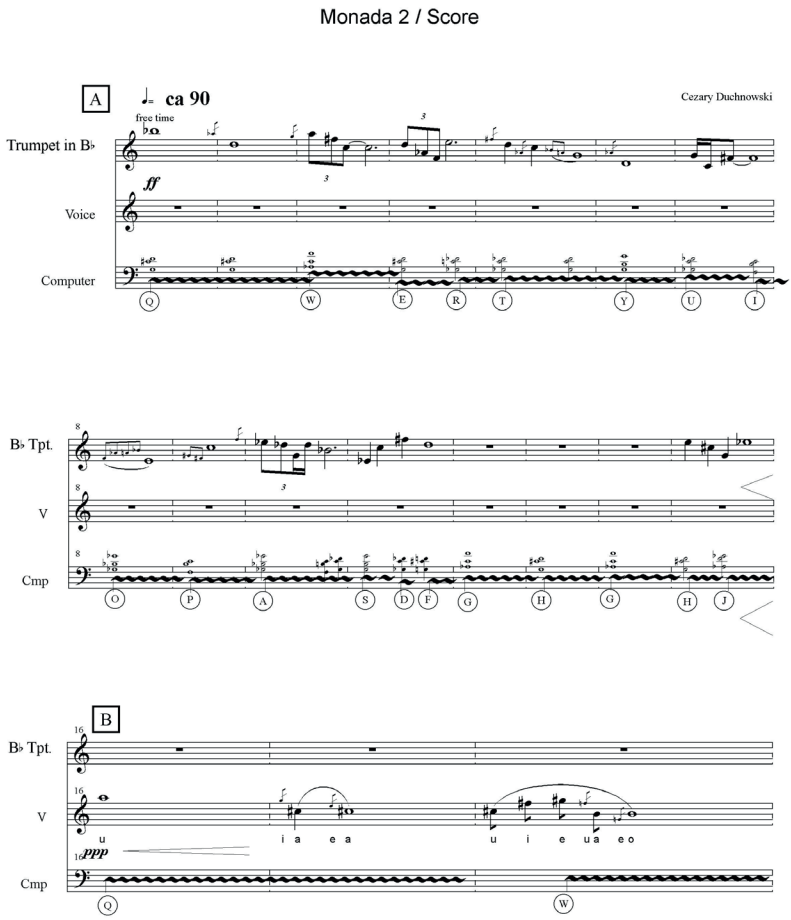
The fusion of the human voice with electronics, utilised by Duchnowski in projects by the *ElettroVoce* duo and employed for the first time in his composition *Dishevelled Grass* (2002), found a continuation in *m o n a d 2* for voice, trumpet and computer (2003).[831] The basic principle of this fifteen-minute form's dramaturgy is the juxtaposition of these three sound media.

Monad 2 begins with a strong entrance: a strike of synthetic sounds and a trumpet part, multiplied by electronic transformations. It is only after they have 'faded out' that the vocal voice appears – at first, delicate and melodious, then, more and more expressive, increasingly modified by electronics. In the further course of the piece (one could call it the second phase), these three parts – voice, trumpet and computer – constantly intermingle and intertwine, but, in the wider scheme of things, when it comes to their character and timbre, they remain separate and seemingly non-integral – one could even say, at odds with one another. Their musical 'bickering' shows especially in the middle part of the piece, before calming down until *monad 2* closes with the quiet sighs of voice and a muffled trumpet. The sound matter, having exhausted itself in the musical struggle, completely disintegrates and dissipates.

The score for *monad*, based on computer-assisted note editing, features metric and non-metric bars, setting the framework for the melodic phrases of the trumpet and voice. In the lowest system, in a much-simplified form, the composer represented the computer layer. The interventions of the electronic processing controlled by the

831 *Monad 2* was produced in 2003 at the Heinrich-Strobel-Stiftung des SWR Experimental Studio in Freiburg im Breisgau. The world premiere took place on 22 September 2003 in Warsaw during the 46th 'Warsaw Autumn'. The performance featured: Agata Zubel (soprano), Piotr Wojtasik (trumpet) and composer – Cezary Duchnowski (computer).

sound engineer are indicated by consecutive letters, corresponding to the buttons on the computer keyboard (for convenience, from left to right).[832]



Example 52. *monad 2* – the beginning of the piece

One characteristic feature of *monad 2*, also present in many of Duchnowski's other works, is the complete absence of expressive terms. On the one hand, the composer permits the performers to shape the expression freely, while on the other, he allows it to emerge spontaneously, as it arises from the sound structures themselves, even more so from radical electronic deformations and deconstructions.

832 The piece could be performed without an additional person controlling the computer – the keys may be pressed by the person performing the vocal parts.

The vocalisation in the foreground is given special treatment here. The use of the word 'singing' to describe it is a matter of convention; in reality, the composer, relying on the creative interpretation of the performer – as stated in his own commentary on the cycle – allows the performer to take quite a few liberties. The text, deconstructed and broken down into syllables, is treated as sonic material more so than semantic. The vocal part, full of expression, passion – ferocity, even – abounds in cries, screams, squeals, and later also in less turbulent wails and laments. The fragments of the floating melody are devoid of text and rely on vowels, only combining themselves into meaningful words on an incidental basis (*death*, *kill*, *such a monad*).[833] Instead, it is their timbre and type of expression that become telling – the voice sounds trapped, wandering, and contorted in pain, yet, at the same time, unable to express itself fully; it is a 'muted speech' of sorts. The use of live electronics means all the vocal effects are further emphasised, but also made to sound less real.

The trumpet part no longer presents this wide a range of musical emotions. Its melodic phrases are seemingly indifferent to the voice and the bruitist computer layer, which, in turn, abounds in 'dirty' and crackling noises. The sounds produced by live electronics become a warped mirror reflection of the instrumental and vocal parts – the sounds are distorted and uncouth, like untamed musical elements. Thus, Duchnowski manages to significantly enhance the power of expression. The transformations performed by the computer system are very complex. Sometimes, even single trumpet or voice notes unleash entire constellations of sounds or – in the second phase of the piece – cohesive, slowly growing timbral bands. In its overall shape, however, the electroacoustic layer is completely dominated by the noisy sounds of very high variability. They may be compared to the practices of introducing deliberate sonic flaws within genres of electronic music such as noise or a glitch.

The 'sonic schizophrenia' causes *monad 2*, especially in its first movement, to be dominated by an atmosphere of anxiety, nervousness, and disagreement. The textural space, despite relatively-limited articulatory variety (especially in the trumpet part), remains heterogeneous until the end. The insistent attempts at establishing a dialogue between the voice and the trumpet end up exhausting the material rather than reaching a point of conclusion. This is why *monad 2* seems

833 A similar use of text may be found in 2002's *Dishevelled Grass* for voice and computer.

like a surreal musical painting – its elements do not combine into a logical whole or harmonise with each other, although they are forced to come together on one sonic plane. The path to a symbolic reading of this situation is indicated by the composer in the very title. Indeed, the concept of 'monad' appears in several philosophical systems, the most important one being Gottfried Wilhelm Leibniz's theory of monads. The term used by the philosopher usually refers to a simple substance, a basic unit. At the same time, monads are independent entities, not subject to external influences; they are closed worlds, living for themselves. A similar independence and 'self-ownership' may be perceived in the three instrumental layers-parties operating in the piece by Duchnowski.

A direct continuation of the ideas and concepts accompanying *monad 2* is *m o n a d 3* from 2003, written for voice, piano and computer.[834] This instalment of the cycle is half as long as the previous one (lasting just under eight minutes), but may be divided into three phases: the first, a dynamic-factural crescendo, the second, a kind of expressive and rapacious solo piano cadenza, and the third, subdued and lyrical. In the first and second phases, the musical matter is scattered and fragmented, while the third phase is dominated by longer and subtler quasi-melodic phrases. The score's legend precisely defines the requirements for the computer to be used (Macintosh), as well as for the software (Max/MSP, with a special patcher created for the piece, named M3dsp by the composer; GRM Tools Classic, TC Native Reverb Plus, and TC Works SparkGrainalizer), and describes how the performers control the electronic media: the pianist uses the sustain pedal, and the singer uses the computer keyboard – the signs in the score specify when a key is to be pressed.[835]

The piece's score is quite austere, with the piano part in places pointing to the composer's use of controlled aleatoricism. The vocal part, on the other hand, in contrast to *monad 2*'s complete absence of text, opens up the individual choice of all sorts of means of performance, articulation, and expression by the singer. They are not noted in the score, as they are left to the discretion of the interpreting artist.

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834 Commissioned by the Warsaw Experimental Studio of the Polish Radio, the piece won First Prize at the 10th International Rostrum of Electroacoustic Music in Rome in May 2004.

835 In the first part, they are the number keys: *1, 2, 4, 5, 7, 8*, and, the second, the functional keys *enter* and *backspace*, as well as and letters (the entire lower row): *z, x, c, v, b, n, m* (cf. Examples 53, 55, 56). Thus, the computer becomes an instrument of sorts.

In the available recordings of the work,[836] it was predominantly throat singing, without vibrato, but with characteristic overtones intoned on various vowels and phonemes.

When it comes to the piano, the score of the piece, rather than intervening in the final melodic-rhythmic shape, more often tends to merely define the sound material up for free interpretation. A characteristic trait of monad 3 is the use of a very limited set of sounds.[837] Due to this, the first phase of the work may be divided into nine sections: according to the score, each one of them may can last between 10 and 30 seconds. Here, the dynamics and textural density of the layer of processed sounds increase successively. The episodes develop in an evolutionary manner, bringing more and more extended motifs in the vocal part, and more and more extensive sound material in the piano part.

Table 3.
Sound material of the first phase of *monad 3*

Episode	Vocal part	Piano
1.	*B C E*	-
2.	*B C E F A*	*B*
3.	*B C♯ D♯ G A*	*B C*
4.	*B C D♯ E F A*	*B C D♭*
5.	*B C C♯ D♯ E F G A*	*B C D♭ E♭*
6.	*C D♭ F G A*	*B C D♭ E♭ G*
7.	*B C E F G*	*B C D♭ E♭ G A*
8.	*B C C♯ D♯ E F G A*	*B C D♭ E♭ G A*
9.	*B C♯ D♯ E F G*	*B C D♭ E♭ G A*

The live electronics give the sounds of the vocal part sustain, resulting in a dense and noisy quasi-cluster, a sonic 'fog' of sorts. Thus, when it comes to the intervals, the role of seconds seems to be a particular one, causing dissonant friction and the formation of differential tones and beats, further accentuated by the live electronics.

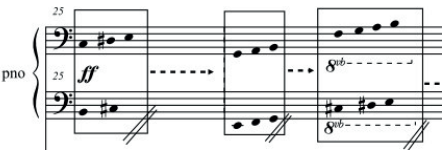
836 The piece has thus far only been performed by the duo ElettroVoce.

837 Even in *Triads* for string orchestra and electronics (2002), Duchnowski applied algorithmic models and a strict sound order according to a scale with an interval structure expressed in semitones as follows: 2–1-2–1-1–2-1–1. From it, he derives triads of a specific structures; from three such triads – which is undoubtedly related to the work's title – compound chords are constructed.

Generally speaking, the modifications made by the computer do not alter the sound of either the voice or the instrument overly much, besides – in the recordings made hitherto – they are kept at a low dynamic range. They serve primarily to thicken the texture, through the use of various types of reverb and delay lines (echo effect).



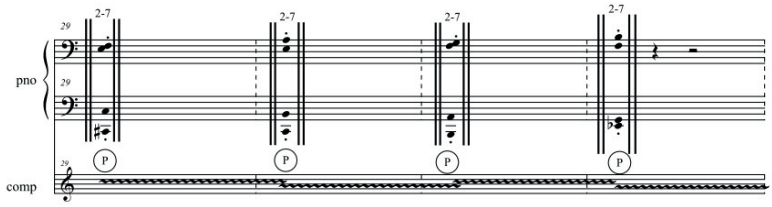
Example 53. *monad 3*, piano part: notation of pitch classes (sounds performed in any register); live electronics part: noise quasi-cluster



Example 54. *monad 3*, finely rhythmic, fast motifs intended for aleatoric execution

Towards the end of the first phase of the piece, the short, ragged motifs turn into a shout (reminiscent of the ritual calls of some primitive, savage tribes). Not long after, brief, sharply-articulated piano sounds join in phase two. These dissonant, staccato structures fuel its restless

atmosphere. Chordal repetitions with an unspecified number of repetitions – from two to seven – play the role of a solo cadence of sorts in the second phase of the piece. They are written in a rhythmically-free form, only to be brought to life by the performer.



Example 55. *monad 3*, a passage from phase two

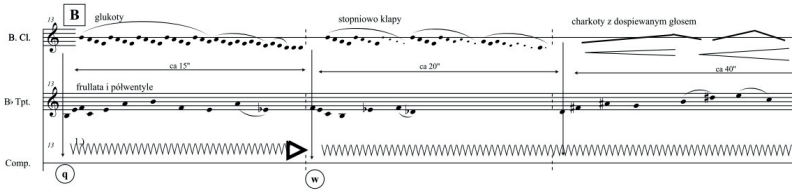
In the third and final phase of *monad 3*, the vocal part should be performed exactly (*ordinario cantabile*). The piano part, although devoid of rhythmic values, does not leave as much freedom of interpretation as in the first and second movements either. The role of electronics in this quieter phase of the piece remains constant. Here, both the voice (this time, reminiscent of a siren's song) and the piano (errant cantilenas) weave long, lulling melodies. The lyrical motif chains forming them, ever higher in register (in the vocal part, the composer requires that the sounds be 'as high as possible'), disintegrate towards the end of the piece, only to dissolve completely in a fog of filtered, rustling electronic noises.

Limiting the role of the computer to that of executing the transformations causes the instrumental and vocal parts to dominate in *monad 3*. The electronics do not so much transform the current sound as slightly modify it, but also stop and add up (albeit at a lower dynamic level), due to which some sounds are reduced to the role of a textural binder or background. Owing to the use of limited sound material in the overall shape, the texture is clearer, and the actions of the electronics are more intelligible. This reductivity was likely intended to find 'pure' and 'primal' sounds.

Monad 4 was intended by the composer not so much for instruments as for specific performers, as, in the title, he specifies: 'for Baron, Wojtasik, and a computer'. The designated persons: clarinettist Piotr Baron and trumpeter Piotr Wojtasik, well-known jazz musicians, were the first and so far only performers of the solo parts in this piece.[838]

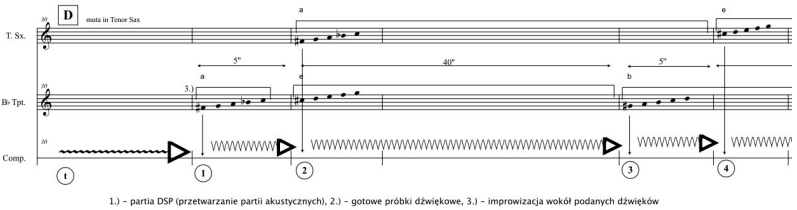
838 The premiere of *monad 4* took place on 23 February 2004 during the 24th 'Musica Polonica Nova' Festival, as part of a concert by the Computer Music Studio of the Wrocław Academy of Music.

In *monad 4*, as in the rest of the cycle, the score serves more to delineate the sound material than to specify the melodic shape of individual parts. Here, Duchnowski delineates six phases, assigning them successive letters of the alphabet. Phase A is the acoustic introduction of the bass clarinet. In phase B, it is joined by the trumpet and processing electronics, with the composer requiring the instrumentalists to produce and articulate sounds in such particular ways that he needed to write the instructions using descriptive, non-musical terms.



Example 56. *monad 4* – the beginning of phase b

When it comes to the bass clarinet, the C phase is a faithful copy of phase A notation-wise, but, this time, the sounds are transformed by the computer. In phases D and E, the composer permits improvisation within the designated sound material. This material is selected so that within one musical section the saxophone and trumpet parts have only one sound in common. At the same time, one may notice that the saxophone part takes over the trumpet sound material from the previous section. In phase F, the instruments fall silent, with only the electronic processing layer remaining.



Example 57. *monad 4* – phase d

In *monad 4*, Duchnowski exploits the idiosyncrasies of the jazz musicians' sound and the energy of their improvisations by electronically expanding them. The ways of transforming the instrumental timbres in *monad 4* range from adding reverb, through pitch changes, and

overdrives to loops, giving one the impression of the sounds being 'trapped'. This, in turn, may be related to the overarching idea of Leibnizian monads, present throughout the series.

In *m o n a d 5 for a minimum of three improvising musicians* and a computer, the element of free execution is of even more importance – one might say, crucial. It is complemented by a conceptual element – as the 'score' of the piece does not contain notation, but a script of sorts for the improvising musicians, only setting the formal framework of the piece. First, the composer instructs each musician to answer four questions pertaining to the core of musical performance: (1) What is your favourite timbre/sound? (2) What is your favourite timbre/sound produced using your instrument? (3) What is playing music to you? (4) Do you prefer to play solo or in a band? The responses of the individual musicians given in sound form, recorded and registered by the composer, become the basic sound material of the electroacoustic layer. Duchnowski processes them, then uses them during the performance of the piece, where they are interactively controlled by, among other things, the dynamics of the instruments being played live.

In *monad 5*, one may distinguish four distinct phases whose course is determined by the conductor-leader coordinating all the activities of the musicians. In the first phase ('A – Presentation'), each performer plays their favourite sound individually, as if answering the first question; in the second phase ('B – Interruptions'), electronics are activated to overlay and loop the musical answers to question No. 2; and in the third phase ('C – Pairing'), the performers 'answer' in pairs; in the fourth, they play in any order. The score does not contain any instructions related to the direction of the electroacoustic layer, as it is carried out using a Max/MSP patch and controlled by two MIDI keyboards (so the notation of these parts does not correspond to the final sound results) and electronic percussion. This procedure is automated, and occurs alongside the progress of the composition. The manner of multiplication, the transformation models, and the parameters – regulated and mediated – are automated and regulated by computer algorithms.

In *monad 5*, Duchnowski wanted to find a compromise between a determined formal construction and freedom in terms of filling it sonically – an unfettered creation of sounds. In order to achieve it, the composer abandoned musical notation altogether, distancing himself, in a certain sense, from the final shape of his own work.

The performance of *monad 5* thus takes the form of a conceptual performance, during which the questions posed to the performers may also inspire deeper reflection in the audience.

The cycle of *monads* is relatively coherent in terms of concept, sound and form, notwithstanding the fact that the composer's activities here pursue two goals that would seem mutually exclusive: on the one hand, to reach a primordial, universal sonority, and, on the other, to find new means of musical expression. What is characteristic, the scores of the individual *monads* are devoid of expressive terms. The piece is intended to be filled with performance expression born spontaneously, in the course of the performance, giving the soloists space to display their abilities. Thus, the *monads* are, on the one hand, a study in shaping sound from scratch and, on the other, in deforming it to enhance expression.

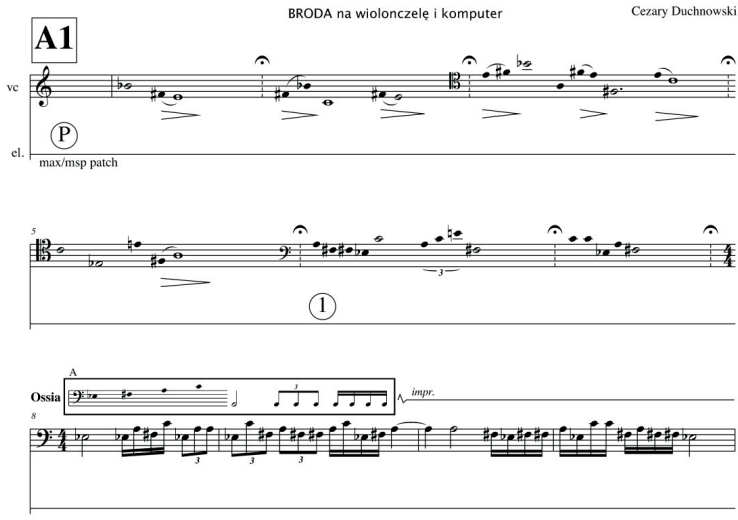
An of experiment of sorts, intended to draw the listener's attention to the issues of improvisation and the perception of musical time and form already tackled in *monads*, is *B e a r d* for cello and computer, created in 2005.[839] Here, the instrumentalist is able to choose between a strictly-notated part and its semi-improvised version, with the scale and possible rhythmic figures given by the composer. The experiment is foreshadowed in the ironic commentary on the piece:

> Everything is going somewhere, towards something, maturing in its duration, and losing blossom at the end of survival. The trees that we grow into are things that we never grow out of. In spite of that, we burn, we walk, we swim, we fly, and we burn.
> …and whether there is something that so persists that it is, or only changes so slowly or so quickly that it is difficult to perceive.
> Whether time grows or passes – time like a beard to the max, a beard for adults, a beard for Andrzej's cello and for Andrzej Bauer. My enthusiasm for festivals of note and commentary is overgrowing, although they are the faithful spouses of music festivals.
> …after all, at a concert, a sly note is sometimes the only way to kill time.
> …kill time?
> …well, one could cut their beard, just listen to the music.
> – One can certainly kill time.[840]

839 *Beard* is part of the *Cellotronicum* project.

840 http://www.duchnowski.com/noty.html.

The effects of the electronic transformations are programmed in such a way that the processed layer becomes the background for the cello – in other words, the instrument accompanies itself. The subsequent passages of *Beard*, which consist of melodic cello phrases wrapped around successive sound axes (later in the piece, the names of these sounds are spoken aloud by the performer) are based on limited sound material, so the two layers remain relatively coherent. This also makes the narrative continuous and fluid, making it difficult to divide *Beard* into movements or even phases. The musical plot of *Beard* seems to teeter between continuity and variability, repetition and monotony, necessity and surprise. This peculiar game with perception plays out through the dichotomous narrative of the piece – its progression is, on the one hand, geared towards contemplation and persistence, and development and moving towards a goal on the other. In the piece's final phase, this purpose appears to be absent – the musical matter dissipates as if on its own, dissolving into silence. Thus, it is about a certain effort of auditory observation, of waiting for something that does not come in the end. It turns out that the listener's vigilance is merely 'waiting for Godot'.



Example 58. *Beard* – the beginning of the piece (in the third line – passages transcribed in their undetermined and strict versions)

3.3.3. Intermedia gardens – multimedia projects

Some of Duchnowski's projects transcend the framework of the musical field of art and clearly enter the realm of performative-visual interactions. Already during his studies, together with Marcin Rupociński, the composer produced: *Taps* – a multimedia concert-performance for piano, soprano, featuring a quintet, a dance theatre and an actor (1997), followed by *Morphai* – a multimedia performance for soprano, saxophone, piano, marimbaphone, and electronic media with dance, performance, and video (1998), *Games* – an audiovisual performance for soprano, saxophone, piano, marimbaphone, and electronic media featuring dancers and an actor (1998), *Vernissage* for photographs, piano, and tape (1999) and the audiovisual performance *Sequences* (2001). One may notice the free transgression of genre boundaries and, by extension, the attempt to reach new means of expression.

One of Duchnowski's most important multimedia works is the chamber opera *Martha's Garden* for female voice, actor, electronic media and instruments, created in 2006, with its libretto written by Piotr Jasek. It constitutes a certain kind of synthesis of the composer's ideas when it comes to syncretic activities and the use of new media (in addition to computers and synthesizers, a Wii controller[841] and an iPad are used here in instrument-interface capacity, too). Moreover, the composer invited his artist friends, with whom he has collaborated or is collaborating in various improvisational projects and ensembles, to take part in the performance of the opera. In addition to Agata Zubel (in the role of the titular Martha), Michał Moc (accordion), Andrzej Bauer (cello), Jacek Kochan (drums), and Paweł Hendrich (electric guitar) perform as well.[842] These soloists were included in the musical plot of the performance. What seems to be most important here, however, is the role of electronics transforming the instrumental parts, including DJ Lenar's creation, intended to process the vocal parts (singing and recitation).

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841 The Wii controller (*Wii Remote*, *Wiimote*) is a video game console controller, designed and manufactured by the Japanese company Nintendo. It may be used as a pointing and 3D motion detection device. It also features an acceleration sensor and an optical sensor in the form of an infrared-filtered camera, allowing one to manipulate the pointer or objects in games by making various gestures with it. The Wii controller has a port allowing one to connect various accessories to it, as well as a Bluetooth module that may connect wirelessly to a computer.

842 The actor, Erik Lubos, does not play any instrument, but plays the role of Marta's boyfriend ('Him').

The opera is based on a short story, *Martha's Garden,* and themes taken from the short story collection, *Expiry Date,* by Piotr Jasek.[843] The opera's libretto is a study of human love, in which the taste of fulfilment turns out to be no longer as sweet as when it is a forbidden fruit. As explained by Jasek:

> The form of this piece is a nearly-finished libretto with an original narrative idea. The two protagonists, a boy and a girl, have a dialogue that is not spoken directly to each other, but only directed towards the other. They describe their dreams, thoughts, and requests that they would never dare to say to a loved one, even though they want their confessions to be heard and reciprocated.[844]

It is the story of a girl in love with a boy who is stealing apples from her garden. The characters live out their love, observing the changes they and their feelings undergo. They look for the causes of these changes in the past, which is why the plot's development is not linear, and the whole story has no clear beginning and end. At times, Martha becomes her own mother or grandmother, and the boy ('He') becomes his own father or grandfather. The mundane events between the girl, the boy and their families, in places ironic, take on a deeper meaning in a broader context, describing, above everything else, the passing of love.[845] The dialogues have been kept to a minimum, making each sentence seem even more expressive – which is, however, not to say that there are no moments kept in a mood of 'intimate cosiness'.[846]

The minimalist staging of the opera makes use of the space between the four pillars framing the garden, separated by hanging, semi-transparent, white string tassels, allowing one to observe the musicians seated in the centre and, at the same time, serve as screens for visual projection (Zubel's performative actions include wandering between the musicians and bumping the hanging tassels, which then

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843 Duchnowski has previously used the texts of Jasek's short stories between 2001 and 2008, in his three *Broadcasts*: *Beginning*, *The Aim*, and *Sweater.*

844 Piotr Jasek, *commentary on the piece Martha's Garden*, http://www.duchnowski.pl/ogrod marty.html.

845 Ewa Szczecińska, *Warszawska Jesień 2009. Festiwal krytyków. Moja Jesień 29.09.2009 [Warsaw Autumn 2009. Critics' Festival. My Autumn 29 September 2009]*, http://www.dwutygodnik.com/artykul/503-warszawska-jesien-2009.html.

846 Monika Pasiecznik, *Warszawska Jesień 2009. Festiwal krytyków. Relacja druga 25.09.2009 [Warsaw Autumn 2009. Critics' Festival Second report 25 September 2009]*, http://www.dwutygodnik.com/artykul/503-warszawska-jesien-2009.html.

cast discreet shadows). The audience watches the performers from three sides, while the sound engineers and computer system operators view the stage from the fourth.



Example 59. The Wii and Nunchuck controllers used in *Martha's Garden* as a sound interface

In *Martha's Garden*, the computer is used is less to process instrumental sounds, and more often the other way around: the sound of the instrument controls the actions of the computer. Thus it is the instrumentalist's expression that underpins the final sound shape, even if very deformed. The gestures made using the Wii controller or the iPad touchscreen also have a direct effect on the music – the opera even features a tablet solo of sorts. The musical layer remains understated both when it comes to the lineup (the only mandatory components being a female voice, a male reciter and two harmonic instruments of one's choice) and to the material. The instrumental parts are created on the basis of roughly defined metrorhythmic flows, indications of textural density, and relative pitches. Unusually for Duchnowski, however, the score contains expressive indications.

The *Garden's* narrative is heavily reliant on the interactions between the artists. The sonic and performative actions simultaneously impact the electronically-controlled visual layer. As a result, the music fully corresponds to the projected images, amplifying the power of the message. The individual parts are medially coupled with all the electroacoustic sound events, as well as the visual elements of the performance. As explained by the composer:



Example 60. *Martha's Garden* multimedia opera, Warsaw Autumn 2009

> Sometimes they are the impulses and starting point for other sound events. This kind of situation is a testament to the immense causal power of the characters' dreams. At other times, the situation is reversed, and it is the instruments that play with the voices of the characters. Thus, they expose the relentless and destructive power of fulfilment.[847]

Owing to live electronics, Duchnowski was able to achieve the impression of filling the space with electroacoustic sounds, with little performance activity. This is because the note material for instruments was relatively scarce. The intended sonic effect was determined by a specially-programmed system consisting of electronic media controlled by instruments much more so than by traditional notation. Here the composer makes a division between arias and recitatives, which are, however, not vocal, but instrumental, created by way of interactive improvisation. With their playing, the musicians unleash pre-prepared layers of sound, while at the same time having to enter into an instrumental dialogue with them. The soprano of the titular Martha – at times, extremely lyrical, at other times, rapacious and passionate – is accompanied by him: at first, from tape, then also live. In the partly open, variable form of *Martha's Garden*, the dramatic

847 Duchnowski, commentary on the piece *Martha's Garden*, http://www.duchnowski.pl/ogrod marty.html.

action continuum is disrupted. Some words, motifs, and even scenes are repeated and looped. Mere moments after the introduction, the composer – who has taken part in every performance so far – shouts 'Stop! Again!'. The action loops, but also stops (causing some of those in the audience to start clapping), only to move on after a while.

Duchnowski's multimedia *Martha's Garden* is a hybrid form that straddles the lines between instrumental theatre, performance, and interactive improvisation. It incorporated DJ and noise practices into live- and human electronics music. According to Jan Topolski, the opera is 'a summary and a culmination of the composer's work to date, bringing together many of his favourite motifs and technical means'.[848]

Another of Duchnowski's multimedia projects is *C i t y V o i c e s* for voices, instruments and computer – a work commissioned by the Wratislavia Cantans Festival and premiered at its 44th edition in 2009 at the Cathedral of St. Mary Magdalene. Duchnowski entrusted the production of the music visualisation layer to Maciej Malczak, who illustrated the work's musical layer with 'images of the city' projected onto three giant screens. The coherence between one set and the other allows the piece to be called a three-part multimedia cantata.

The first part features a computer-processed sentence taken directly from the famous medieval *Book of Henryków:* '*Daj, ać ja pobruszę, a ty poczywaj*' (Let me, I shall grind, and you take a rest). These words, believed to be the first ever written sentence in Polish, were broken up and deconstructed by Duchnowski using a specially programmed algorithm into single, purely timbral sounds, which, in a polyphonic performance form a sonoristic counterpoint of sorts. Part two features excerpts from the *Gospel of Luke* (among others: 'Prepare ye the way of the Lord, make his paths straight.'), while in the third part there are passages from the city charter of Wrocław quoted in Latin. In his brief commentary, the composer reveals both his inspirations and the aims he pursued in the creation of *City Voices*:

> The piece is about a city, a large space that inspires me. It is not, however, a literal story of Wrocław, though I have used specific sounds that Wrocław residents may associate with their city. I am trying to create a new musical language, difficult and unintelligible for many, but I would also like listeners to perceive the beauty in my music. I am

848 Topolski, *Z koncertu na koncert. Warszawska Jesień, Ogród Marty [From Concert to Concert. Warsaw Autumn, Martha's Garden]*, *Ruch Muzyczny*, 2009, issue 23, p. 14.

> not a philosopher or aesthetician, and it's not my job to define what beauty is. I think it's just where the positive emotions are. *City Voices* are meant to evoke them.[849]

The musical layer contains both contemporary and historical themes, owing to which elements with purely sonic and semantic-symbolic qualities are juxtaposed on its surface.

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> We live in a world of noise, dirty sounds, commercialism, and new technologies – we cannot in such a world, we can no longer use the old sonic order, and I myself have been bathing in digital images, synthetic sounds and artefacts ever since I was born. Artificial sounds, deformed and put through a filter – they constitute the nature of today's man.[850]

This is what Italian composer, Fausto Romitelli, wrote in the 1990s. Duchnowski, who deconstructs the sound of instruments and the human voice in order to build them anew with the aid of electronics, seems to exude a similar attitude.[851] He uses timbral archetypes, making his works sound raw and 'primal' to the ear, stripped of decorative and artificial embellishing elements. On the other hand, Duchnowski does not give up on shaping the melody (in the instrumental parts) and it is rare that he uses non-traditional means of performance or articulation. Their scarcity is compensated by new means of musical expression based on the expansion, twisting, and deformation of the music through media, up to the limits (sonic, textural) of recognition of the original sound source.

Duchnowski's works are characterised by the sound of processed instruments maintained in the style of noise, glitch, or even industrial music. These sounds give his music a distinct style, and

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849 Adam Domagała, *Kantata o mieście na głosy, instrumenty i komputer [Cantata about the City for voices, instruments and computer]*, *Gazeta Wyborcza* (Wroclaw regional section), 15 September 2009, http://wroclaw.gazeta.pl/wroclaw/1,89918,7042799,Kantata_o_miescie_na_glosy_instrumenty_i_komputer.html.

850 Fausto Romitelli, quoted in: Szczecińska, *Warszawska Jesień 2009…*

851 In the narrative of *Reality On Stretched Braces from a Window* for 2 pianos, strings and a computer (2008), the composer utilised very long pauses, which provoked the audience's suspicions of equipment failure and reactions of impatient listeners during the performance. The composer would record these reactions and process them later in the piece. When it became apparent that Ewa Szczecińska, conducting the broadcast, was commenting on the silence that had occurred, the compositor also used her voice in subsequent performances of the piece.

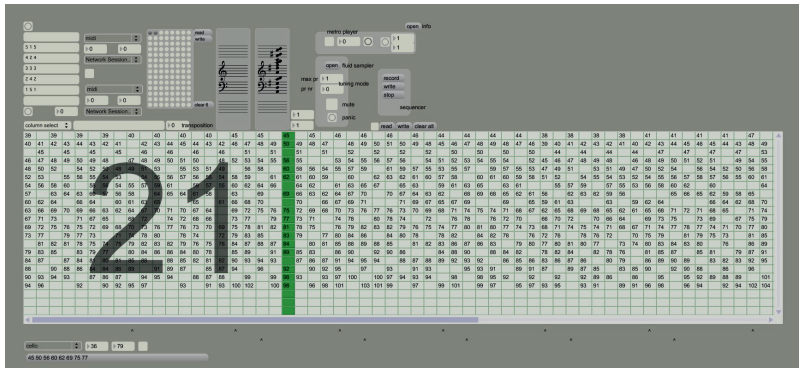
create completely new contexts for the traditional lineup. Within these styles, the composer oscillates between the recognisable and the unrecognisable, aiming to achieve textural heterogeneity while simultaneously keeping the source sound material homogenous. Thus, in Duchnowski's work, the timbre in itself acquires an individual character. It is the substance from which the musical entity is born.

For Duchnowski, writes Dorota Szwarcman, the c o m p u t e r is 'both something more and something less than an instrument'.[852] Something more, because it can be used to control more than just sounds. Something less, because there are no characteristic features, such as individual sound or scale, assumed *a priori*. Everything it does is dependent on the composer programming and controlling it. Thus, the electronics in Duchnowski's works mostly act as an 'extension of the instrument' and expand its musical possibilities by way of the instrumentalist's constant interactions with electronic media. Above all, it is the human v o i c e that proves to be flexible articulation-wise and susceptible to any and all tonal nuances (especially when working with a creative artist like Agata Zubel).

For Duchnowski, computer media also prove indispensable in the pre-composition phase. As part of his work on subsequent pieces, he developed a number of software tools for the o r g a n i s a t i o n o f t h e s o u n d m a t e r i a l, e.g: SysSmell, Dj-Czar, Czardony, and Ranczor. In these pieces, Duchnowski uses various types of algorithms. Due to the high complexity of the structures, analogue media would prove insufficient for real-time implementation during the performance, therefore Duchnowski chiefly uses the Max/MSP open software environment. This allows him to develop various combinatorial and probabilistic algorithms, defining, for instance, melodic-rhythmic relationships. Most often, they have their origins in software-generated symmetrical numerical lists forming strings in which some of the arguments are ascending, and some descending. Groups of such numbers may influence various formal elements in a composition: the harmonic structures, the rhythmic proportions, or even the duration of the successive formal sections. Thus, the software pieces generate various possible variants of the data, from which the composer – through trial and experimentation – chooses those he finds to be the most suitable. In order to organise these chaotic sequences of numbers, 'approximation grids' are sometimes applied to their structures, so that the result only reflects the initial mathematical

852 Szwarcman, *Muzyka 2.1*…

model as a rough estimate. Such grids may include things like the introduction of micro-intervals.[853] Fragments of some regular lists may even be found in the titles of compositions, e.g. *1 5 1*, *2 4 2*, *3 3 3* for violin, cello and electronics (2011) or *10 1*, *8 2*, *6 3*, *4 4* for string quartet with or without computer (2005).



Example 61. The graphic interface of the *Chardony* patch, showing the automatically-generated lists of numbers used in the song *1 5 1*, *2 4 2*, *3 3 3*

The composer's aim was for the n a r r a t i v e to be characterised not by fluidity, but by particularity and segmentation, which is the reason why it is organised in contrasting, sometimes even collage-like ways. The parameters of the respective sections, the rhythmic structures, as well as the way they are grouped may also be generated randomly. On the one hand, they become unique, devoid of periodicity, and not characterised by a fixed internal order; on the other, due to limiting the sound material, they integrate on a higher structural level, even if concretisation occurs by means of randomisation (as is the case with the piece *A Throw of the Dice* for three computers from 2009). The montage-like f o r m with perceptible 'seams' and a jagged narrative or ostentatious repetition only build the logical dramaturgy on the macro scale.

The aspiration to develop a system that precisely controls the various parameters of the work is not at odds with the i m p r o v i s i o n present in Duchnowski's works. It fulfils the dual role of, firstly, abstracting performance expression, and, secondly, interactively controlling the auditory events. Moreover, the improvisation is geared

853 See: Krzysztof Stefański, *Wizytówka Cezarego Duchnowskiego [Cezary Duchnowski's Business Card]*, http://meakultura.pl/publikacje/wizytowka-cezarego-duchnowskiego-802.

towards finding new means of expression. However, as Duchnowski himself points out, 'a true search aims to find something, and an avant-garde search is one for which the aim is the search itself'.[854]

Duchnowski has the nature of a performer and improviser. For him, the ability to interpret the work freely and to have an element of 'experience' associated with a live performance are important factors. He prefers to create music live, so typically he is actively involved in the performances of his works. He then becomes one of the performers and the sound director, sitting at the computer keyboard, the mixing console, and, sometimes, the piano. 'I am profoundly convinced that art should, above all, evoke emotion,'[855] writes Duchnowski. As Krzysztof Stefański points out, Duchnowski understands them

> …more primally, as a strong experience of novelty. However, he does not wish to seek novelty in the external shape of the work, in terms of technical means, instrumentation, or form. He craves novelty at a much deeper level of music, at its most basic component. For Duchnowski, this *a r c h é* is constituted by the sound of the piece.[856]

Hence the use of the computer – an instrument whose open potential greatly aids one in finding a new facet of the elemental qualities of music, unencumbered by any 'weight' of extra-musical content.

By employing highly abstract structures, Duchnowski aims to achieve a wide range of abstracted emotional categories: from joy of life (e.g. *Dishevelled Grass*), through primordial wildness (*monads*) to melancholy (*Martha's Garden*). According to Maciej Jabłoński,

> In Duchnowski's world, there is room both for philosophical motifs and for unrestrained play with sounds or meanings, while the composer evokes the figure of an *enfant terrible*, an avant-garde artist openly contesting the influences of tradition. (…) The composer (…) not uncommonly invokes elements of tradition, but does not identify with any trend or convention. By placing himself above traditions and conventions, he essentially creates them from scratch – often in each of his successive ventures.[857]

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854 *The search for real music. Cezary Duchnowski odpowiada na pytania Ewy Szczecińskiej [Cezary Duchnowski Answers Questions by Ewa Szczecińska]*, *Ruch Muzyczny*, 2006, issue 11, p. 11.

855 Duchnowski, *Summary of professional accomplishments*, p. 6.

856 Stefański, *Wizytówka Cezarego Duchnowskiego*…

857 Jabłoński, *Sacrum profanum 2012: sercem, uchem, szkiełkiem i okiem [Sacrum Profanum 2012: with Heart, Ear, Glass and Eye]*, http://www.dwutygodnik.com/artykul/3948-sacrum-profanum-2012-sercem-uchem-szkielkiemi-okiem.html.

According to Duchnowski, the constant search for new means of expression and new languages of delivery is supposed to lead to the very essence of music.

The polarised situations that one may encounter in Duchnowski's works – e.g. precise algorithmisation versus free improvisation – indicate that he an artist who is constantly searching. In his work, the aim is not only to experiment with sound and deconstruct it, but also to reach musical universals that would clearly reveal the musical being in its very essence.

3.4. Experimental electroacoustics in works by Krzysztof Knittel

Krzysztof Knittel was born in 1947 in Warsaw, where he studied composition with Tadeusz Baird, Andrzej Dobrowolski, Włodzimierz Kotoński, and this is where he currently lives and works. From 1973 until the end of the 1990s, he collaborated with the Warsaw Experimental Studio of Polish Radio,[858] where he created his first electronic works; since then, synthesizers, samplers and the computer have accompanied many of his artistic endeavours. Starting in 2001, he has been a professor at the Academy of Music in Łódź and at the Academy of Music in Kraków.

There are few composers to whom Polish culture and contemporary art would owe this size of a debt of gratitude,[859] as Knittel's field of activity stretches very widely. He is a press and television publicist, co-creator (Ad Libitum) and director ('Warsaw Autumn') of a number of festivals[860]; he collaborated with the 'Solidarity' Culture

858 In 1978, he also collaborated with the Center for the Creative and Performing Arts in Buffalo (USA).

859 Knittel received recognition for his artistic endeavours on numerous occasions: in 1985, he received the Solidarity Award (for his *String Quartet* dedicated to Father Jerzy Popiełuszko); in 1998, he received an award from the Foundation for Contemporary Performance Arts in New York; in 2003, he received the Cyprian Norwid Award, as well as the Award of the Polish Composers' Union; and in 2005, he received the silver medal 'Meritorious Service to Culture Gloria Artis', as well as the gold medal of the Guardian of Places of National Remembrance.

860 The 1990s were a difficult period for the Festival. Following the death of Lutosławski (1994), the Ministry of Culture and the Arts reduced its subsidies and intended to turn the Festival into a biennial lasting several days at a time. Knittel prevented the artistic deterioration of 'Warsaw Autumn'. On the contrary, he began implementing changes that revitalised and refreshed the Festival, attracting young audiences.

Committee (1981), co-founded the Koło Twórców Niezależnych [Circle of Independent Creators]; he was vice-president of the Polish Contemporary Music Society (1989–1992), president of the Polish Composers' Union (1999–2003), vice-president (2000–2005) and president (since 2005) of the Polish Music Council; member of the Supervisory Board of Polish Television (2003–2006); Programme Council of the Zachęta National Art Gallery (since 2004) and Council of the ZAiKS Authors' Association (since 2006).[861]

His work is rich and varied when it comes to genres, subject matter, and aesthetics alike. Knittel composes works for traditional ensembles: orchestral, chamber, and even ballet and choral, but perhaps the most interesting among his works are his electroacoustic and multimedia productions: installations, performances, soundscapes, and all improvisatory and experimental initiatives that go beyond the realm of serious music. These endeavours are connected with Knittel's performance activities as an improviser and performer.[862]

3.4.1. Beyond the sound margin – music for tape

Knittel is one of the first Polish composers to dabble in electroacoustic music this extensively. He began his creative endeavours in this current as early as the early 1970s, when the first synthesizers appeared in the Experimental Studio at Polish Radio in Warsaw. Starting with his debut at the 'Warsaw Autumn' with the project *Points/Lines* for clarinet, tapes and slides (1975), works using various electronic sound media have regularly appeared in the composer's works.

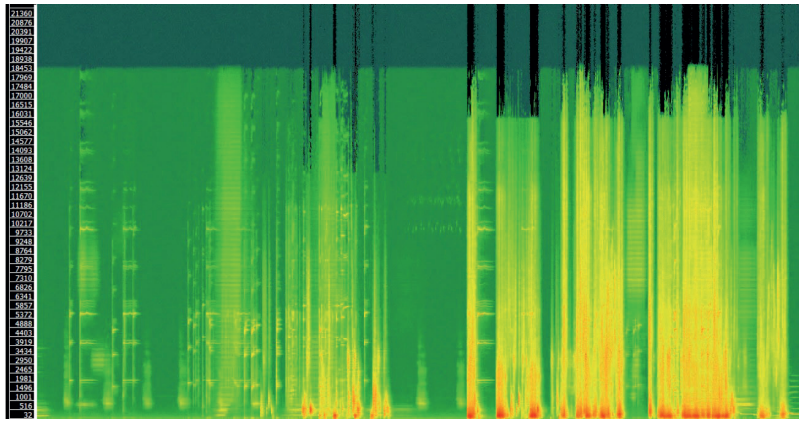
One of Knittel's first important works for tape is *The Conqueror Worm* (1976). It is an electronic poem of sorts, where the abstractness of artificially-generated sounds is broken up by an

861 Elżbieta Szczepańska, *Knittel Krzysztof* (entry) [in:] *Encyklopedia Muzyczna PWM [PWM Encyclopedia of Music]* (Kraków: Polskie Wydawnictwo Muzyczne, 1997), Vol. 5: *KLŁ…*, pp. 111–112.

862 The almost 40-year time-space of Knittel's artistic endeavours is difficult to divide into periods or phases. Instead, one may distinguish certain strands among them. Knittel himself divides his work as follows: 1. cabaret music and sung poetry; 2. 'music of mirrors' – created under the influence of various inspirations and extra-musical phenomena (e.g. *Lipps* or *The Conqueror Worm* from 1976); 3. 'music of ends and odds' – born from, among other things, his fascination with turpism (e.g. *Resztki [Ends and Odds]* for tape from 1978); 4. 'music of good vibrations'. – inspired by the culture of the Far East (e.g. *Black Water*, *White Water*, or *Old Stream* from 1983); 5. 'circa-jazz and circa-rock music' – associated with his activities in the bands Go-Go BeuysBand, Ch&K&K; 6. 'borderline music' – intermingling with other fields of art and teetering on the edge of high art (e.g. *Homage to Charles Ives* from 1992).

evocative, imagination-spurring title, taken from the poem by Edgar Allan Poe. The sounds and noises abounding in the various murmurs, clatters, and crackles here (including transformed trombone and violin recordings) are as unreal as they can be. But it is thanks to the title that they become eloquent and malleable, evoking images of a world of worms, earthworms or other subterranean creatures. Owing to electronic highlights and transformations, the viewer looks at this world as if through a magnifying glass, seeing it with a big, 'acoustic zoom'. 'Zooming in' and 'eavesdropping', however, does not take away from this music's aura of mystery and rawness. And, much like Poe's text, with its intelligible, yet macabre message, it compels one's imagination.

Here, Knittel's aesthetic stance manifests in his use of electroacoustic sounds from the category of noises and crackles, described by the composer as 'marginal sounds' and 'music of ends and odds'. The term was taken from the writings of Samuel Beckett. It was from the title of one of the Irish playwright's short story collections, *Ends and Odds* (1974), that another of his works for tape, *Resztki* (1978), took its name. Indeed, Knittel based it on the Moog synthesizer-processed noise of the Niagara Falls, as well as and excerpts from the 1974 recording of his *Form E* for brass quintet and lights.



Example 62. *the conqueror worm* – 3′00″–5′30″, spectrogram showing episodes of varying textural density; sonic bands (left part) and blocks of noise (right part)

3.4.2. The charm of nonconformity – works for tape and instruments

The experiments in the radio studio allowed Knittel to confidently enter an area that – as it would later turn out – he ended up falling in love with, i.e. the juxtaposition of various media, especially tape and electronics, with 'live' instruments. One of the more important achievements in this trend is *dorikos* for string quartet and tape (1977). The piece consists of seven parts – musical miniatures – of several minutes each. The tape part is entirely filled with *concrète* material – it features, among other things, the sounds of the street, hurried footsteps and scampering, animal voices, thunder, and muffled recitation, creating in and of themselves a silent radio play or film track of sorts. These sounds hardly ever undergo transformation or modification, although some (such as the flapping of sails) remain difficult to identify. What is more important, however, is the fact that their presence changes the way the quartet plays the live functions and is listened to. The music of the four strings instruments, abstract and asemantic in its shape and sound, acquires meaning through the sounds of the tape; it does not, however, constitute a direct illustration, but, rather, a kind of musical commentary, and, at the same time, an emotional addition. The piece's rhythmic layer, devoid of any regular pulse, has been planned in a characteristic manner. The rhythm, and, by extension, the musical timing, are malleable, flowing freely and naturally.

The fourth miniature, central to the entire series, uses a tape recording of Zbigniew Herbert's poem *What Mr. Cogito Thinks about Hell*, recited by an actor. This ironic text may become a key to reading the work. By quoting it, Knittel betrays that he is aware of the dangers carried by ideas of progress:

> Throughout the year competitions, festivals, and concerts are held here. There is no climax in the season. The climax is permanent and almost absolute. Every few months new trends come into being, and nothing, it appears, is capable of stopping the triumphant march of the avant-garde.

Although Knittel boldly goes beyond the framework of the traditional understanding of art, he remains aware of the dangers and pitfalls present in musical experimentation; after all, complete artistic freedom may, in fact, enslave.

Of relevance is also the title. The Greek word 'dorikos' (δωρικός) means one of the most important architectural orders of antiquity.[863] It is not without significance that, in that style, artistic qualities gave way to functionalism. A similar situation seems to be the case in the piece – the sonic possibilities of the electronic transformations are radically limited and remain in the background, as the meaningful and associative function of the recordings is of more importance. To put it in simpler terms: the tape offers the listener 'dry facts', while the quartet offers vivid emotions. These layers intensify each other's expressivity, though, in musical terms, they remain disproportionate. This method of composing – juxtaposing and superimposing elements that are alien to one another, this heterogeneity – would become one of the most defining features of Knittel's work. *Dorikos* itself, meanwhile, may be viewed as the first step towards acoustic ecology and soundscape, a genre taken up by the composer 30 years later.

3.4.3. Message-driven electroacoustics – religious works and musical 'monuments'

It is rare for a sensitive artist to remain passive in relation to the surrounding reality. However, among contemporary Polish composers – especially those interested in electronics and new media – it is difficult to find a figure exhibiting an interest in social and political issues as strong as Krzysztof Knittel does. Many, especially his later works, touch upon social, historical and national themes, but also ethical and religious ones. There are several compositions in which the very fact of having reached for a certain theme rather than another, usually suggested in the title, is a significant artistic gesture in itself.[864] The clear outlining of the meaning of the works makes it possible to classify them as part of the trend of 'music with a message', where, by reminding us of the greatest traumas of Polish 20th century history,' notes Andrzej Chłopecki, Knittel 'awakens the conscience of the nation'.[865]

863 The term also refers to the Doric scale employed in the instrumental parts of the *dorikos*.

864 Back in the mid-1980s, at a time of increasing awareness of the evils of communism, Knittel composed his *String Quartet 1984–85* (1984–1985), dedicated to Father Jerzy Popiełuszko. The piece was premiered on the first anniversary of the priest's tragic death at the St. Stanislaus Kostka Church in Warsaw, where, during his lifetime, Popiełuszko organised and celebrated his famous Masses for the Fatherland during martial law.

865 Andrzej Chłopecki, *Muzyka naszych czasów. Krzysztof Knittel [The Music of Our Times. Krzysztof Knittel]*, (CD liner notes) PRCD 079, Warszawa: Polskie Radio, 2006.

Knittel's later works also include several pieces with religious themes, including *Out of the Depths I Cry unto Thee, O Lord* for choir and tape to texts of the Psalms (2000)[866] and – above everything else – *St. Matthew's Passion* for solo voices, mixed choir, two percussionists, string orchestra and electronics (2004). It is a work that is all the more important and 'message-driven' because it is placed in the context of the present day and contemporary man. Here, the Passion narrative is conducted in an unusual way, as the Gospel text is interspersed with flashbacks from Christ's life narrated by actors, recounting His most important deeds. And the significance of these deeds is emphasised in the very context of death.

The electronic part – played from a compact disc – remains somewhat in the background, completing and diversifying the sound of the string ensemble, giving a specific atmosphere to the whole. Indeed, in the musical layer, the composer juxtaposes various compositional techniques: almost all of the vocal phrases and a large part of the accompaniment are written in twelve-tone, while other parts employ the collage technique. Thus, in *Passion*, the composer juxtaposes disparate worlds – symbolically combining an archaic, millennia-old form with 21st-century techniques and media.

The same is true of *El maale rahamim…*[867] for mixed choir, symphony orchestra and tape (2001), a work dedicated to the memory of the victims of Jedwabne. The bluntness and variety of the means used here reflect the tragic significance of the work well. This several-minute-long prayer cantata is simultaneously a musical collage where heterogeneous planes, alien (one might say: disjointed) in sound and expression, collide. Knittel's approach to the new media used in the piece, whose participation is typically of primary importance to the composer, is quite symptomatic here. In *El maale rahamim…*, their use is not a goal in itself, but the said media are a vehicle for meaning, serving only as a tool to implement ideas that are impossible to execute for a traditional orchestra.

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866 It is a cycle of four compositions composed to the texts of the *Psalter of David* from the *Millennium Bible* (part I uses the text of Psalm 130, part II of Psalm 23, part III of Psalms 117, 51, 102, 103, part IV of Psalm 150), commissioned by Polish Radio's Programme II (dedicated to Anna Szostak and the Camerata Silesia Singers' Ensemble).

867 The title (in Polish: *Boże pełen miłosierdzia…*) is a reference to the incipit of the Jewish prayer for the dead. This prayer appears at the end of the piece, both in Hebrew and in its Polish translation, with the choir divided into two groups singing the two language versions simultaneously.

In the overall formal plan of the piece, one may to distinguish two parts: the first, stormy, chaotic and noisy from the outset, and the second, orderly, psalm-like. This duality gives birth to a dramaturgy founded on simple, yet powerful and expressive opposites: chaos versus orderliness, cacophony versus euphony, textural density and power of sound versus dilution and delicacy. Furthermore, the first movement may be divided into two phases, and the second movement into three – each of the phases is separate and distinctive, each outlining a different circle of extra-musical references.

The first phase is an orchestral *tutti* lasting several minutes, with the choir struggling to penetrate through it. Here, the composer used and musically reworked fragments of the texts of seven Yiddish songs that enjoyed popularity in Poland before World War II. The various textural plans are juxtaposed in a collage-like manner – not only does the choir part hardly match the orchestra, but the melodies of the individual songs are also layered on top of each other, forming a polylinear, polytonal bundle. In this part of the piece, the choir is divided into four mixed groups. The parts of each group are conducted independently, carrying different texts, and having different metres and tempos; they are not synchronised, but, rather, disjointed. The second phase two features a recording of the voice of Shmuel Wasserstein (played from a CD), who for many years came from overseas to recite the traditional kaddish at the stone in Jedwabne. The orchestra part emphatically fuels the drama of the mournful sentences. The heavy, massive frullatos and tremolos of the brass instruments, the quasi-cluster string verticals and the shouts of the choir no longer sound prayerful, but aggressive and sinister. After a while, Wasserstein's voice is electronically transformed, becoming quivering and bubbling, as if unreal.

The second part of the piece is less expressive and less dramatic in tone. The successive phases bring a gradual calming, offering relief and soothing the senses. The musical matter seems to dissipate, dissolving into the air. In the third phase, 'sound waves' appear (as described by the composer himself, but they could well be called 'scream waves'). Although they appear to sound peaceful, they are in fact a combination of the sound of ocean waves and the screaming of children. Here, the composer alludes to the memories of one Jewish survivor, whom the sound of the ocean reminded of the screams of the people from the burning barn in Jedwabne, carried by the wind. The fourth, instrumental phase slows down the action even further. The order and textural arrangement present here in no way resemble the

chaos of the piece's beginning. The harmony becomes important – the unanimous-sounding chords and gently undulating melodies in the string part are reminiscent of chorale phrases. The piece concludes with a telling sentence: 'Oh Lord, please forgive us our sins', quoted in Polish, English and Hebrew. These last words, spoken with the orchestra silent and without unnecessary exaltation, as if 'with heads bowed', constitute a *post scriptum* of sorts.

El maale rahamim… is a musical statement by an artist genuinely concerned about human tragedy, but devoid of empty pathos or attempts to artificially fit into the contours of the occasional piece. It is a 'short and powerful' piece,[868] as its creator does not focus on exposing the media or the aesthetic values of the music, but, rather, on the message carried by the work. Each phase gives the piece a new sonic quality, but also a different expression and meaning. The collision of the Ivesian layered orchestra with the voice played from tape may symbolise the moment when the flame of hundreds of lives was consumed by fire. There are multiple interpretations for the children's cries mixed with the sounds of ocean waves. The ominous ripples cannot be stopped, and the nightmare keeps coming back. The ocean, on the other hand, is a symbol of remoteness; it is an obstacle making it difficult for Jews from America to make the pilgrimage to Jedwabne and other places branded with the stigma of the Holocaust. Solace to the senses is only brought by the second movement. The stringed chorale and the kaddish that follows restore calm, offering the longed-for respite. The prayer, sung by the choir in Polish and Hebrew, as well as the request for forgiveness of trespasses repeated in Polish, Yiddish, and English, are a sign of reconciliation, moving the meaning of the work into a universal dimension.[869]

El maale rahamim… is a musical memorial to the fallen, but also a warning to the living. Its value and function go far beyond sound – the aesthetic qualities (beauty of sound, logic of structure) are of secondary importance here, with the primary focus being on the symbolic gesture – full remorse in the face of bitter truth.

Equally tragic when it comes to content and expression is *A Memoir of the Warsaw Uprising* for actors, female choir, piano, cello, symphony orchestra, and 6-channel electronic

868 Dorota Szwarcman, *Menu (Wydarzenia – Polska) [Menu (Events – Poland)]*, *Wprost*, 2001, issue 29, http://www.wprost.pl/ar/10606/10606/?I=973.

869 In the final bars, the original version of the score featured the following words: *Please forgive the sins of this nation*. The composer decided to change their meaning by including the following adage: *Oh Lord, please forgive us our sins*, in a certain sense shifting the burden from the nation directly to each of us.

tape (2004), with text by Miron Białoszewski. This harrowing, musicalised record of human tragedy, told day by day (63 parts in total), took on a form not unlike a radio play. Notably, here, in contrast to Knittel's other works, the two layers – verbal and musical – here are compatible. The music has clear objectives – to illustrate, emphasise, and accentuate the text. Despite being in the background, the electronics used in the piece play a significant role. It complements the sound and expression of the dry, factual recitation, illustrating the text and adding depth to it. As noted by Andrzej Chłopecki:

> On the one hand, it deepens expression owing to its timbral saturation, 'innervating' the timbres of instruments and voices; on the other, it is used as if the electronic sounds were to create a framework for these 'traditional' sounds, transporting them into the generalising metaphor zone.[870]

3.4.4. Spontaneous interaction – intuitive and improvised music

Knittel's artistic explorations oftentimes lead to the boundaries of art music, especially given that he always found playing and toying with sounds appealing. He had already been active in experimental ensembles since the late 1960s: first, in student groups (theatre and cabaret), then in intuitive music groups. Starting in 1969, he collaborated with the student cabarets 'Abakus' and 'Stodoła' (with Magda Umer). He has also composed music for theatre and television productions, as well as for films.

> Bach, Chopin, Liszt, Wieniawski, Rachmaninoff, Szymanowski – all of these outstanding European composers were able to improvise. After all, what does the compositional process begin with if not with the search for the form of a piece through improvisation? The current education system emphasises perfection in performance, and only in jazz does improvisation play a fundamental role, being a test of both the musician's perfection and creative ability, their imagination and ability to create musical form in real time, as well as their proficiency in the use of the instrument. The art of improvisation serves this purpose, helping one develop imagination, creative skills and the ability to work together as a team. It also instills in one the ability to quickly and appropriately react to the unexpected, the new, and the surprising.[871]

870 Chłopecki, *Muzyka naszych czasów…*

871 Kajetan Prochyra, *Kompozycja zaczyna się od improwizacji – rozmowa z Krzysztofem Knittlem [Composition Begins with Improvisation – a Conversation with Krzysztof Knittel]*, http://jazzarium.pl/przeczytaj/wywiady/kompozycja-zaczyna-się-od-improwizacji-rozmowa-z-krzysztofem-knittlem.

Knittel's musical performance, especially improvisation, is not linked to any traditional instrument – it employs exclusively new electronic media. The basic tools here are usually analogue and digital synthesizers, samplers, and a computer. His works also sometimes feature more outlandish ideas – for example, in the 1982 performance *Man-Orchestra I* for any instruments and tape, the composer hung various objects which he played on his own body. In his own words:

> Then I started to improvise more boldly, at first not even caring whether it worked out for me or not. I began to find my own voice in improvisation. I called it 'sounds from the sidelines'. I left the whole 'centre' of the sonic universe behind and searched on its periphery, in the zone of noises and crackles. I considered it my sonic world, thus not taking away the bread and butter from musicians playing traditional instruments.[872]

Knittel's proclivity for musical improvisation is linked to working in a collective: Knittel is a co-founder or member of numerous performance and composition ensembles. In the early 1970s, together with Elżbieta Sikora and Wojciech Michniewski, he initiated the K E W Composer Group. The three composers collaborated to create the *Second Secret Poem* for electroacoustic equipment and slides, one of the first Polish multimedia works, premiered at the Warsaw Autumn Festival in 1974 (i.e. before Knittel's own, individual festival debut). Through this group, Knittel was able to implement and develop his main interests and predispositions: creating in a collective and improvising.

In 1986, together with Piotr Bikont and Marek Chołoniewski, Knittel founded an ensemble bearing the mundane name Pociąg Towarowy. It is a group that steers its aesthetic trajectory towards performance art and the borderlands of jazz.[873] In 1989, owing to Knittel and Chołoniewski, Studio C H & K was founded, dealing primarily in live electronics. Ten years following its formation, the two were joined by jazzman-multi-instrumentalist Włodzimierz Kiniorski; the duo became a trio and was renamed C H & K & K. Since 2004,

872 Michał Mendyk and Jan Topolski, *Krzysztof Knittel – interview*, *Glissando*, 2005, issue 3, p. 35.

873 A number of jazzmen have worked with Pociąg Towarowy, including Tomasz Stańko and Włodzimierz Kiniorski. In addition, the band's concert compositions have served as music for silent films: *Schatten* (directed by Arthur Robison), *Orlaks Hände* (directed by Robert Wiene) and Faust (directed by Friedrich Wilhelm Murnau).



Example 63. The CH&K&K improvisation and performance group (from the left: Marek Chołoniewski, Włodzimierz Kiniorski, Krzysztof Knittel)

Knittel has also been a member of the K a w a l e r o w i e b ł o t n i, an ensemble founded by Jerzy Kornowicz, featuring Ryszard Latecki and Tadeusz Wielecki. The band continues to tour regularly to date.[874] For Knittel, collective composing, intuitive music, and artistic 'group work' constitute opportunities for disparate musical personalities to come together:

> What better opportunity can there be to get to know another person, if not through direct contact, conversation, and the exchange of views? The same spirit, after all, accompanies chamber music. These moments spent exploring music together are extremely creative, on many levels.[875]

874 Knittel's career has also seen episodic, less serious projects, such as the improvisatory ensemble with the distinctive name Cytula Tyfun da Bamba Orkiester, initiated with Andrzej Bieżan, Mieczysław Litwiński and Tadeusz Sudnik, which in 1981 played concerts in schools and even in a juvenile detention centre. Between 1982 and 1984, the Independent Electroacoustic Music Studio was active, hosting Knittel's clashes with composers such as Stanisław Krupowicz, Paweł Szymański, or Andrzej Bieżan. This group performed both improvised music and works by individual composers of the Independent Studio. After its disintegration, Light from Poland (1985–1987) was formed – a Silesian formation featuring, apart from Knittel himself, the poet Tadeusz Sławek, Mieczysław Litwiński, and Bogusław Mizerski.

875 Mendyk, Topolski, *Krzysztof Knittel – interview…*, p. 36.

In a small group of a few people, one may enter into a special, truly intimate musical dialogue. And not just when one is dealing with people they know and understand well.

3.4.5. Electroacoustic encounters and dialogues – the cycle of *Sonatas da camera*

Yet another facet of Knittel's creative endeavour and performance and improvisation activities are his eighteen *Sonatas da camera*. Their lineup includes both traditional and electronic instruments (synthesizer, sequencer, computer, etc.), the latter typically used by the composer himself. It is within this group of works that Knittel has developed a distinctive way of employing electronics for improvisation: the range of sounds and effects he uses is usually limited to murmurs, clatters, sometimes also beats and samples straight out of electro or even techno music.



Example 64. Sketch for *Sonata da camera No. 15* (2005)

The sonatas were composed with specific performers in mind, who are generally excellent improvisers. The first (1994) was written for the outstanding jazz trumpeter, Tomasz Stańko, while *Sonata No. 2* (1995) was written for Marek Chołoniewski, who received a synthesizer specially designed for the occasion by a friend of Knittel's, Jan Pieniążek.

The synthesizer produced the simplest sounds possible: sine, sawtooth, rectangular tones – and offered rather limited possibilities for effects such as reverb or the ability to control one generator using another.

The dedicatee of *Sonata da camera No. 8* (2000), was Andrzej Chłopecki, who carried out an improvised analysis of the work on the fly, during its premiere. This improvisation was conducted on two interpenetrating levels – as a monologue, in the form of a play on words, and as a dialogue, involving interaction with Knittel's part. Fragments of Chłopecki's radio programmes were also woven into the electroacoustic layer.

In the theatrical-musical *Sonata No. 16* (2006) for three actors and instrumental ensemble, composed with the famous Orkest de ereprijs ensemble in mind, Knittel was interested not in the traditional form, but, as he writes: 'something on straddling the lines between happening, performance, theatrical burlesque and the musical piece. And yet, on top of that, its subject being itself…'.[876] Knittel wished to conceal the musical and theatrical concept of the work until its premiere. He even requested that the conductor refrain from informing the festival organisers about the progress of the preparations. Indeed, all the acting was meant to be a surprise for the audience. For this reason, Knittel suggested that some parts be entrusted to professional actors who could give the entire situation a natural feel.

Sonata da camera No. 17 (2005) was created for the MIDI-controlled organ purchased by the Academy of Music in Łódź. When the composer found out that the organist who was to perform the piece had never improvised before, he changed the concept of the Sonata to use *Kontrapunktus X* from Bach's *Kunst der fuge* and older composition of his own, *Surface en rotation*, played from tape. During the concert, the organ part was controlled using a computer, via MIDI.

The *Sonatas da camera* hardly fit into the sphere of high art. They are largely improvised, and their value is only evident in performance. The *Sonatas* also do not have scores in the traditional sense. Their graphic notation acts as an arbitrary communication system between Knittel and the soloists, intended to stimulate their imagination. Typically, the notation is limited to outlining a general plan of action: the order of the parts, tempo changes, and dynamics – without specifying pitch or rhythm values. In these scores – which are half graphic,

876 Krzysztof Knittel, quoted in: Piotr Roemer, *Muzyka dźwięku i wydźwięku. O Sonatach da camera Krzysztofa Knittla [Music Sounding and Resounding. On Krzysztof Knittel's Sonatas da camera]* [Bachelor's thesis] (Kraków: Akademia Muzyczna w Krakowie, 2010), p. 83.

half verbal – the traditional, note-by-note method of notation finds virtually no application. Owing to this, the performers enjoy a rather large degree of freedom.

The sonic qualities of the respective *Sonatas* is determined by who they are dedicated to. The person invited into the musical 'conversation' is not merely an interpreter, but also a co-creator of the work. The soloist, typically before the concert, is given a recorded electronic part in the form of an improvised demo. This is not the final variant, but rather a recording that serves to give one an idea of the entire work. The only aspects that are established are the macro-form, the number of parts, the type of timbres and processors used at any given time, and, sometimes, the outlines of some sound structures. In a concert setting, this matter is complemented by perhaps the most important element – the interaction between the soloists. After all, improvisation and musical dialogue are an inherent part of the *Sonatas*' nature.[877] These qualities have the strongest impact on the concretisation of form, which is most often additive, collagistic or processual. Knittel writes:

> To me, being a musician or composer does not mean playing, noting down sounds, writing on score paper, or arranging more tapes. 'To be' is 'to be' – therefore, to exist for oneself and for others. To live in music, to meet others, to touch with sound. Others, oneself, us. To not stop at the full stop behind a note, to not put that dot behind a note in the first place – to play that note in a way that will evoke further notes in oneself and in others.[878]

Knittel's own statement is thus formulated using analogue and digital samplers or synthesizers, while the instrumentation of the invited soloists is varied, starting with ancient instruments (viola da gamba), through traditional ones (violin, double bass, piano, organ, or even orchestra), electrophones, to the human voice. 'I started work on each of the sonatas by selecting timbres and sounds, by creating a certain set of data. That was my basis. The concept emerged while working with the said sounds'[879] – admits the composer. This style of working has its origins in the praxis of performance. Knittel has always started from the sound itself, not from its concept. For him, it was important for him to be physically in touch with the sound and to repeatedly try

877 Roemer, *Muzyka dźwięku i wydźwięku…*, p. 5.

878 Jerzy Armata, *Krzysztof Knittel – żyć w muzyce [Krzysztof Knittel – to live in music]*, *Magazyn filmowy*, 2016, issue 7, p. 63.

879 Knittel, quoted in: Roemer, *Muzyka dźwięku i wydźwięku…*, p. 16.

to combine phrases of one kind or another. This is where the form of the works came from. Usually, however, the sound content was merely an excuse for a 'musical encounter'.

The composer himself captured the essence of such music in an apt and illustrative way by comparing it to a theatre play based on didascalia alone, where the generally outlined form must be filled in with content by the actors themselves. The rapport and freedom enjoyed by the performers carries over into the narrative of the piece and how it is received. Also inversely – by way of feedback – the quality of understanding between the musicians is influenced by the mood of the audience. The sonic results may change considerably with each performance, as the *Sonatas* are open to chance, experimentation and imperfection. This, in turn, stands in line with the ideas of Bogusław Schaeffer:

> Limiting a piece to the framework of a definitive arrangement does not meet the conditions we set for contemporary music. By composing music with different versions, we open up access to penetrating those ranges which, in the composer's earliest consciousness, are considered to be the most fluid.[880]

Here, the relationship between the instrumental and electronic parts alludes to free-jazz practices that aim to 'replace the work with action'.[881] At the same time, this activity implements the idea of making music together, which is particularly close to Knittel's heart. It is not merely about sonic or rhythmic congruence, but about creating a specific state of interaction and a friendly, musical dialogue. Thus one might say that the *Sonatas* are written not so much with the instrumentalist as with the human being in mind, and that each *Sonata* is a new invitation to have a musical conversation with them.

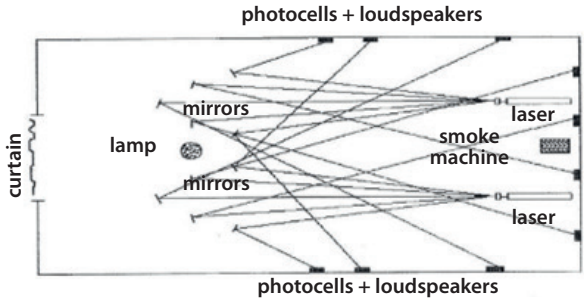
3.4.6. Sculptures, passages and labyrinths – multimedia installations and performances

To Knittel, an important factor is the universal artistic element that transcends sound material and lies at the heart of all art. For this reason, his creative efforts often extend beyond the field of music, manifesting in collaborations with visual artists, directors, actors,

880 Schaeffer, *Wstęp do kompozycji [An Introduction to Composing]* (Kraków: Polskie Wydawnictwo Muzyczne, 1976), p. 70.

881 Topolski, *Co za licho? Krótkie wprowadzenie do muzyki alternatywnej [What the Fuzz? A Brief Introduction to Alternative Music]*, *Ruch Muzyczny*, 2008, issue 1, p. 8.

and dancers. Knittel's early works from the time of his studies already indicate his interest in combining musical and visual media (*Points/Lines* for clarinet, tapes and slides, 1973, *Form A* and *Form E* for wind quintet and lights, 1973). This idea is continued in the 1991 collection of sixteen graphic computer compositions: *Man – Nature*. Knittel is also the creator of many sound installations, most of which were created in the 1990s in collaboration with Jan Pieniążek[882] – e.g. *L e g s*[883] (1993), a peculiar light-sound environment. Sounds were generated here by interfering with laser beams. These beams were scattered around the dark room at leg height, so it was the movements of the audience that caused the interactive system to make different sounds.



Example 65. Installation diagram for *Legs*

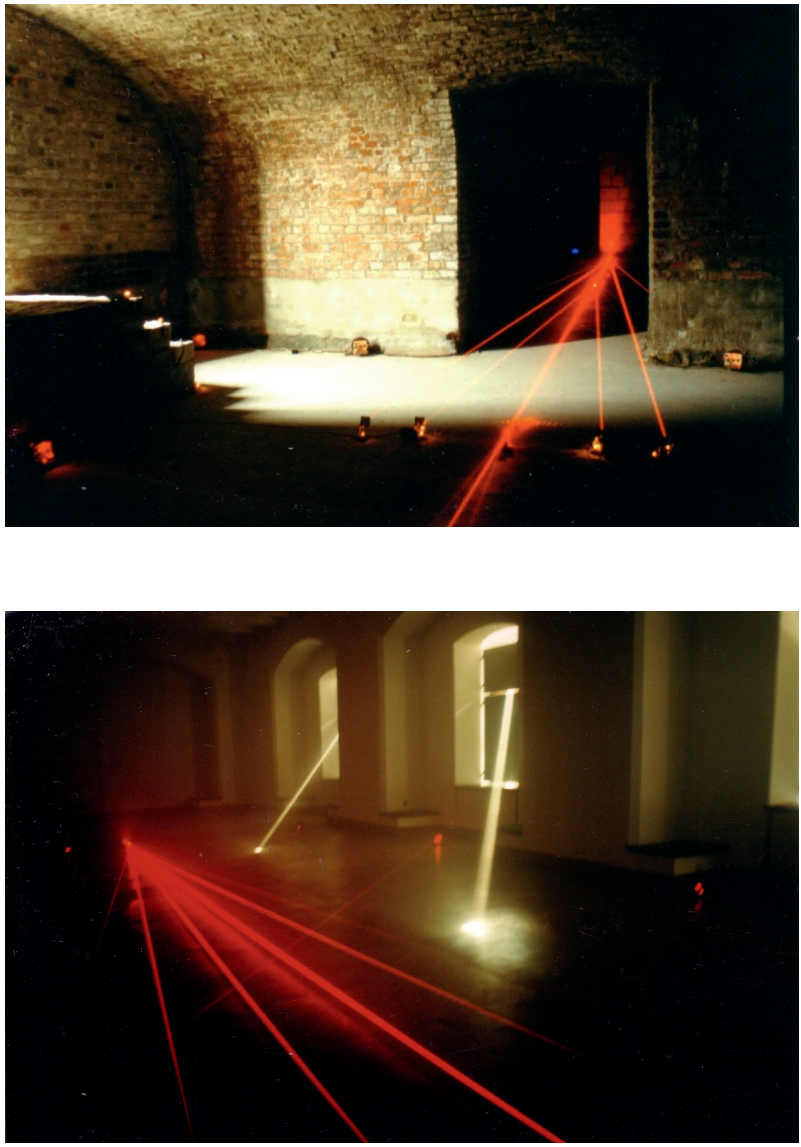
A year after *Legs*, he made further 'one-off' interactive sound installations *Disco*, *Zuzanna's Dream* and *Radio Sculpture* (1994), presented at various festivals in the form of a stack of radios. All of them were obsolete models in wooden casings, making this stack similar to historic bricolage musical sculptures by Jean Tinguely (*Radio No. 1* from 1960, *WNYR No. 5* from 1962), by Robert Raushenberg (*Oracle* from 1965) or by Chris Burden (*Radio Sculpture* from 1979).[884] In

882 Jan Pieniążek is a Warsaw-based photographer, electroacoustician and multimedia artist who creates interactive spatial installations and sound objects; he is a member of the Academy of Movement theatre, where he is involved in sound design and special effects.

883 The installation *Legs* was first presented at the Zamek Wyobraźni (Castle of Imagination) festival in Bytów in 1993.

884 Such works are also being produced today. The most famous ones are *Untitled* (for William Tager, 2006) by Dave Dyment and *Sound Barrier* (2006) by Norwegian sound-artist Maja Urstad the latter in the form of an enormous wall made up of 130 portable radios and CD players.

Knittel's *Sculpture*, the radio receivers are arranged in the shape of a hollow pyramid. They are functional and have the back of the casing removed so that one may look inside them.



Example 66. The *Legs* interactive installation, Maastricht 1994 (above), Szczecin 1996 (below)



Example 67. The *Radio Sculpture* interactive installation, Poznań Music Spring 1995

As in *Legs*, there is virtually no possibility of passive reception of the work in the installation *P r z e j ś c i e* (1994).[885] It is a site-specific project created for the area of the Entrance Gallery at the Centre for Contemporary Art in Warsaw, which has the character of a traffic route. Along the corridor, Knittel placed ten loudspeakers equipped with optical sensors integrated with the sound system. A passerby would trigger another speaker, hearing the murmuring, humming sounds 'travelling' along with them through the gallery. Each passerby becomes, more or less consciously, an interactive performer and listener at the same time,[886] and the sounds become part of the sonic impact of the passage. As Knittel noted:

885 In 1972, an installation with the same title was built by Krzysztof Wodiczko. It included two separate corridors equipped with a system of mirrors whose multiple reflections gave the illusion of moving through an unreal, infinite space. The participant would, for instance, see their own back in front of themselves.

886 Marta Dziewanowska-Pachowska, *Znaczenie ruchu ciała w przestrzeni na przykładzie dwóch instalacji interaktywnych: Przejście K. Knittla (1994) i Garage M. Chołoniewskiego (2000) [The Significance of Body Movement in Space on the Example of Two Interactive Installations: Passage by K. Knittel (1994) and Garage by M. Chołoniewski]* [in:] *Zwrot performatywny w estetyce…*, p. 176.

> Merely walking by did not produce music – it was only when someone stopped and blocked the beam of light falling on the sensors with their hands that the installation 'came alive'. Of course, anyone who passed by would trigger the sounds in the speakers, as they had to cover the lights as they passed, but that was the first impetus for them to stop for a while and start playing.[887]

One larger multimedia project was the 'double opera' *Heartpiece* (1999) – a work created in collaboration with an American artist, composer and guitarist, John King. Its libretto is based on the text-play *Herzstück* by German playwright Heiner Müller (also featuring interwoven turpist fragments of texts by Miron Białoszewski). The entire opera is permeated by elements of musical and visual improvisation. 'Both in its content and form, [it is] surreal and absurd, employing avant-garde musical means, mocking tradition, and shattering sonic habits.'[888] Although, according to the composer, the piece was written in the traditional form, encompassing a theme with variations, the two composers wrote most of the material separately and independently. During the premiere, Knittel played synthesizers, and King played electric guitar; in addition, both of them used their voices. The scenography for the performance, prepared by Krzysztof Zarębski, was created 'in real time', as a performance woven into the stage action (Zarębski dubbed this idea 'active set design').

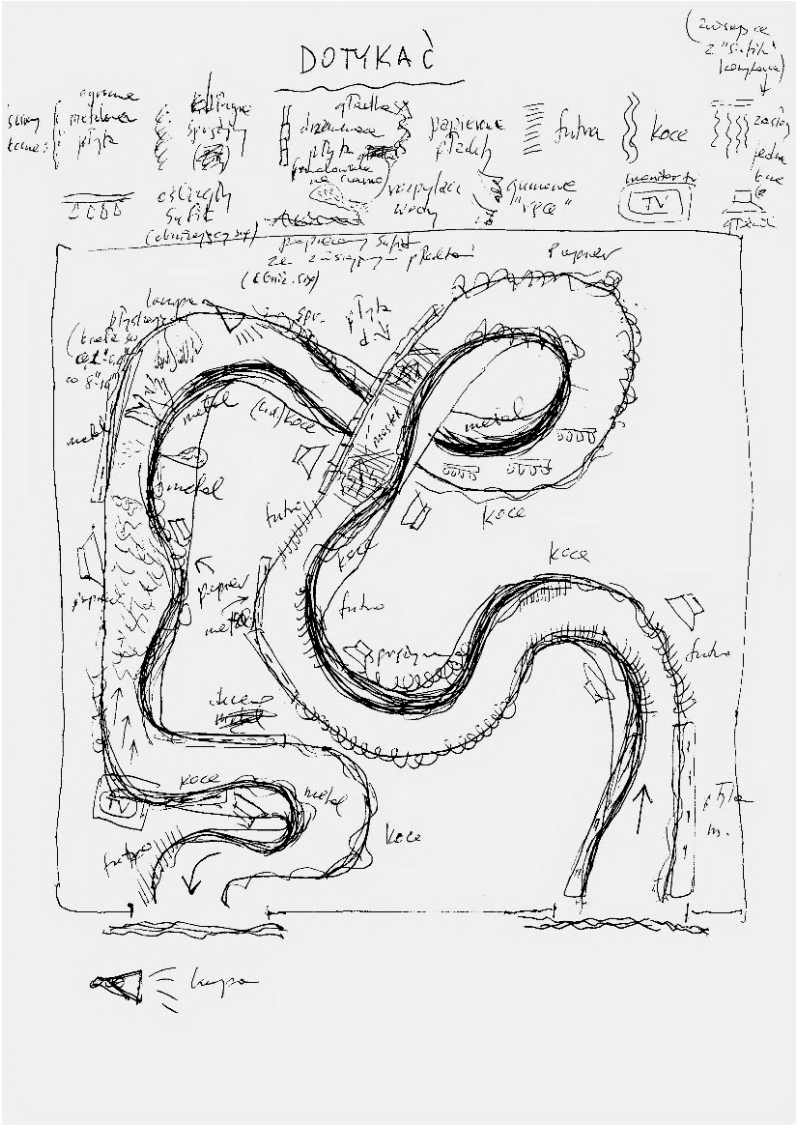
To Touch a Snake from the Inside (2003) is a tactile-sound project designed for younger audiences. Just as the title suggests, this installation allows one to 'squeeze' through the snake's digestive tract, touching its 'guts' by exploring the various structures of the materials used: metal, wood, paper, fur, blanket, etc.

In 1995, at a Berlin workshop organised by the Akademie der Künste at Trebnitz Castle in Brandenburg, Knittel presented the video installation *Raum der Begegnung* (*Meeting Space*). Based on the ideas contained therein, an installation with the characteristics of a happening was created ten years later (2005) – *Społeczne – aspołeczne [Social – Antisocial]*. The project is, in essence, no more than an open invitation to make music together. In his commentary on the piece, Knittel explains:

887 Knittel, quoted in: Dziewanowska-Pachowska, *Znaczenie ruchu ciała…*, p. 177.

888 *Krzysztof Knittel, John King, Heartpiece – Double Opera*, http://culture.pl/pl/dzielo/ krzysztof-knittel-john-king-heart-piece-double-opera.

The starting point is the idea of a meeting open to anyone who would like to come and spend a while in the place where I will be playing. If that person brings an instrument, they can play with me, but they can also sing, dance, draw or paint on sheets of paper hung on the walls, recite a poem or act in any other way this person (and my guest) finds artistic.[889]



Example 68. A sketch of the installation *To Touch a Snake from the Inside*

889 Knittel, http://www.janpiekarczyk.art.pl/klub/pokaz_13_06_05.html.

The first four hours of the performance are recorded on videotape so that, in the fifth hour they can be displayed simultaneously on four monitors in their mediatised form.

3.4.7. An album of sonic snapshots – soundscape

Knittel's fascination with the richness of random ambient sounds (close to Cage's aesthetic) steered him towards Raymond Murray Schafer's acoustic ecology, ambient, and soundscape.[890] This led to the creation of *Four Seasons*,[891] released in 2008 as a four-disc album. Each of the discs contains at least one hour of recordings from five different locations: *Summer* comes from Cimochowizna, a small village on Lake Wigry; *Autumn* comes from Warsaw (including the artist's own flat); *Winter* comes from Krynica Górska (Jaworzyna) and the Tyrolean valley of Hintertux in Austria; and *Spring* comes from the island of Rhodes. The author stresses that these were places that he has 'known and loved for years',[892] so he tried to render his own listening impressions subjectively, and as accurately as possible.

The *topos* of the seasons has a long tradition in musical literature, but it is difficult to consider the set of recordings prepared by Knittel a typical electroacoustic composition. This is, in fact, a special kind of field recording organised into four documentary soundscapes. The recordings are quoted as-is, with no transformation, *in crudo*, with all the baggage of contexts and references, maintaining the chronology of events. The popular music fragments appearing here do not function as quotations, but are an integral part of the soundscape. This distinguishes *Four Seasons* from commercial releases for relaxation. Certainly, Knittel's recordings may fulfil this role, too,[893] but their

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890 Knittel, *Między rzeczywistością a kreacją. O przenikaniu świata realnego i rzeczywistości artystycznej na przykładzie cyklu utworów 'tanie imitacje' [Between Reality and Creation. On the Interpenetration Between the Real World and Artistic Reality on the Example of the 'Cheap Imitations' Cycle]* (Warszawa: Wydawnictwo Uniwersytetu Muzycznego Fryderyka Chopina, 2010), p. 27.

891 He had already betrayed an interest in sound ecology. In 2002, the 10th Audio Art Festival in Warsaw featured a joint performance by Polish dancer Ewa Wycichowska, singer and composer Jorgos Skolias, and Knittel as performer. They presented an extended version of the 1983 piece *Black Water, White Water, Old Stream*, which was written in one of the villages of the Beskid Sądecki and takes its title from the names of the mountain streams located in three neighbouring valleys. The project featured a combination of dance, singing and electronic instruments.

892 Knittel, *Między rzeczywistością a kreacją…*, p. 97.

893 'One may treat this unusual CD set as a sound composition, but also as a music therapy or lullaby of sorts (and not only for children),' – he wrote in the album's liner notes.

meaning is much deeper. This is because they have their own inherent narrative and extra-musical programme, as outlined in the words of the author's commentary. Here is an extract from the description of the first tracks featured on *Spring*:

> 1. 24.05.07, after 10 p.m. – I recorded cicadas hiding in the palm trees and in the grass on the seaside Berlin Street, opposite the Alfa Beach Hotel in Kolymbia on Rhodes Island – with the sounds of cars, scooters, pedestrians, and sounds of the disco from the Atlantic Imperial hotel (ah, what a name, a powerhouse!) beside me
> 2. An almost night-time recording of the sea waves on the beach by the hotel and the still-ongoing disco, with only the bass guitar audible from afar
> 3. 25–05-07, around 1 p.m. – we are on Anthony Quinn beach, 20 km from Kolimbia, beautiful, we learned of its existence from the guide-book; international company, some Germans, next to a group of young Italians; we came here on borrowed bicycles; above the beach, there is a pub where we have lunch – delicious, and this view for dessert – a divine, if short holiday
> 4. I recorded the sea next to our hotel at different times and in different places – I don't even know when I made this recording; does anyone not like the sound of the sea waves?
> 5. Epta Piges – well-known springs in the mountain range a dozen kilometres from Kolimbia, this is also where we arrived on our bikes, and it's another route on the same day – in the distance, one can hear a peacock screaming, forest birds, and from behind the trees probably some goats?
> 6. I also recorded Epta Piges up close, about a metre from the water; the voices of the birds, like an art nouveau ornament, accompany the noise of the mountain stream
> 7. And here is another recording of Epta Piges sources; the birds love this place, and I'm not surprised, it's like a green oasis on this dry orange-yellow ground
> 8. It's almost nighttime – now, from the hotel window, I'm recording drunken music in a nearby tavern, and there's still a lot of traffic on the street
> 9. 26–05-07 in the morning – beach, kids, a normal holiday day
> 10. In the evening, I heard a lone cicada in the palm tree leaves below our hotel room window, what a robust sound – I couldn't help but record it!

Knittel – as writes Ewa Cichoń – urges admiration for:

> …the steady splashing of water being hit with a paddle, the sound of rain hitting the window sill, the sound of people's voices and language, the creaking of snow compressing under the skis. To marvel at the exotic beauty of the phrases played on the stair railing or the utterly rapturous charm of the song *Hej Sokoły* sung by the folk ensemble. Voices of people and voices of birds, machines, and nature.[894]

The recordings were not processed, but the very use of these exact microphones, as well as the way they were set up, make certain noises more audible than others. The composer's role here entailed primarily skilfully picking out the characteristic details. New media, in turn – condenser microphones, digital audio recorders, digital storage media – made it possible to capture the audiosphere with all of its sonic and spatial nuance. By contrast, dividing all the material into brief parts and putting it on a digital medium means that the listener is able to navigate and 'read' *Four Seasons* like a hypertext. Within the full sound picture proposed in the original order, they may arrange his own narratives and images. This permits multiple interpretations. On the one hand, *Four Seasons* is an album of sound snapshots, as the composer captures details of interest to him from the world around him, using the microphone like an acoustic lens. Since the material was recorded in various locations, *Seasons* is also an audio travel report of sorts. The listener may only enter the spaces evoked virtually, through acoustic immersion. Knittel's soundscape may also be read like a sound calendar, as the successive episodes are assigned not only to the title seasons, but also to specific dates. The master plan here is set by 'the rainy monotony of summer (with its surprises), the bustle and peculiar televisual and domestic stereophony of busy autumn, the snowy hum and unexpected shenanigans of winter, and, finally spring with its exotic splashing and bird chirping'.[895] The seasons are also a word-and-sound diary, a direct and permanent record of unique moments of rest, work, meetings with friends and even private, positively intimate situations.[896] By doing so, the composer allows one to get to know him better, permitting the listener to adopt a 'Knittelian' view of the world.

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894 Ewa Cichoń, *Dźwięk, jak co dzień – muzyka ekologiczna? [Everyday Sounds – Ecological Music?]*, *Ruch Muzyczny*, 2008, issue 21, p. 38.

895 Cichoń, *Dźwięk, jak co dzień…*, p. 38.

896 The commentary on the last track reads: 'at the end, I landed on the beach again, by the pebbles moved by the returning wave, and made a recording from 2 metres away – all of this went on for so long that I burned my back "lobster red" and could not sleep for half the night despite having been lubricated with a special aloe vera liquid by a neighbour at the hotel, a Polish woman from Mława, but that's another story…'

The soundscape, as writes Mariusz Gradowski:

> …is not an ontological reality existing independently of human perception. It is a soundscape simultaneously received, perceived, construed (explained in one way or another) and shaped by the listening – or just hearing – human being. (…) with every person perceiving a particular soundscape simultaneously changing it. More or less consciously, they compose.[897]

Knittel finds musical value in the mundane sounds of everyday life by separating them from their natural entourage and inscribing them into the framework of an aesthetic situation. The composer writes:

> We are not accustomed to listening to the sounds of the natural environment attentively (I mean both the countryside and the city) or finding aesthetic value in them. (…) We only notice them when they bother us or start giving us pleasure. Thus, we hear it, but we don't listen to them.[898]

The peculiar aestheticisation of the sound reality present in *Four Seasons* allows one to relate the piece to Wolfgang Welsch's theory of 'aesthetic thinking'.[899] Indeed, Knittel counters the increasing obliviousness to the various musically-enthralling acoustic stimuli available in 'ordinary', everyday life. Ambient sounds – until they are written into the framework of a musical work as a purposeful and meaningful element – are typically not put on a par with music. *Four Seasons*, however, despite the radical limitation of sound directing and musical compositional means, is a multi-dimensional work. In addition to private playback, Knittel envisages the possibility of presenting the recordings as an installation, with the four discs played stereophonically and in parallel (without interruption) from four sets of loudspeakers set up in the corners of a large room, or in four separate and partially darkened rooms. The presentation may be accompanied by folders containing photographs of the places where the recordings were made and their descriptions.[900] In such circumstances, the *Four Seasons* become an immersive audiovisual landscape featuring a stratified, virtual space.

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897 Mariusz Gradowski, *R. Murray Schafer – pan od przyrody? [R. Murray Schafer – Mr. Nature?]*, *Glissando*, 2004, issue 2, p. 58.

898 Knittel, *Four Seasons* (CD liner notes), Sonosfera 2008.

899 See: Welsch, *Estetyka i anestetyka*…; Welsch, *Estetyka poza estetyką…*

900 In this form, the project was presented in 2008 at the Elektronischer Frühling Festival in Vienna, the Re-wizje Festival at the Palace of Culture and Science in Warsaw and at the Edward Hartwig Photography Gallery in Wigry. In 2010,

Excerpts from recordings of *Four Seasons* have been used by Knittel in his *cheap imitations* for flute, clarinet/bass clarinet, piano, string quartet and computer (or CD),[901] where they accompany the sounds of the acoustic instruments. Here, the characteristic elements of the soundscape become the specific 'themes' – as the composer calls them – of the individual parts of the work. In part one (*cheap 1)*, the theme of 'oars' appears in fragments A, B, C and D, the theme of 'motorboats' in E and F, the theme of 'crickets' in episode G, and so forth.[902] In the second movement, the sound of sea waves collides with the percussive rhythm of electronics; in the third movement, the sounds of the ski slope precede the salvo of New Year's Eve fireworks; in the fourth movement, a 'sound photograph' recorded in the window of the composer's flat constitutes the background for acoustic instruments.

It is difficult to concur with the composer's view that 'the meanings associated with a recognisable sound source are lost' in *cheap imitations*, or that 'the content of the recordings ceases to influence the meaning of the music and its perception by listeners'.[903] On the contrary, one would be inclined to think that it is the noises, their references, and the contexts contained in the recordings that direct the reception completely.

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Knittel's aesthetic stance is well reflected in the following thought:

> The current period represents an astonishing symbiosis of opposites. We instinctively pick out antinomies in our surroundings – beauty owes its existence to ugliness, good to evil; it is only to the essence of concepts such as God and the Universe that both extreme, absolute values and all the shades in between belong. It is becoming ever more natural for a sensitive human being, aware of increasing contrasts and an ever-improving social and self-hypocrisy, to struggle between many opposing values.[904]

Four Seasons were recreated at the National Centre for Contemporary Art in Moscow, together with video paintings by Jana Aksjonova.

901 The title comes from the piece *Cheap Imitation* (1969) by Cage, who, in turn, borrowed it from *Socrate* (1918) by Eric Satie.

902 See: Knittel, *Między rzeczywistością a kreacją*…, p. 57.

903 Knittel, *Między rzeczywistością a kreacją*…, p. 106.

904 Knittel, commentary on the piece *dorikos* [in:] *Warszawska Jesień '77. 21. Międzynarodowy Festiwal Muzyki Współczesnej, 17–25 września 1977] [Warsaw Autumn '77. 21st International Festival of Contemporary Music, 17–25 September 1977]*, [programme book], pp. 182–183.

The falling into extremes and the state of 'symbiosis of opposites' pointed out by Knittel become the main determinants of the shaping of musical matter. The composer prefers variety over homogeneity, and fragmentation over integrity. He is not concerned with order, tidiness, or harmony; he does not strive for synthesis. Usually, he just wants to expose differences, juxtaposing and contrasting the heterogeneous, extreme, and non-integrable. Such is Knittel's basic compositional strategy – for 'the most interesting thing in music is supplementing a common phrase with different thoughts'.[905] Seeing as Knittel values talent, creative enthusiasm and sincerity among artists above academic training, this peculiar 'polyphony of thought' does not come as a surprise.

All 'innovations' and 'experiments', allow the creator and the viewer alike to perceive art in a different perspective. But the general artistic ideas and strategies adapted by Knittel had already been present in art for many years – from the first painting collages, through bricolage, Dadaism, to the postmodern, ironic and perverse fusion of tradition and modernity. This remains in line both with Knittel's stance on music and on ideology/aesthetics stance, aiming to juxtapose and play with opposites:

> Today, the idyllic philosophy of harmony of the spheres comes across as illusory and dangerous. It is reminiscent of a paper version of the system, where, with a firm hand of 'Good', crowds of the willing and unwilling are led in the established direction of 'Beauty'. Rather than to a propaganda pamphlet, I prefer to compare art to a litmus test – to explore the relationship of contradictions without false matching.[906]

Thus, above 'Beauty' and 'Goodness', Knittel places Truth.

Knittel intends to utilise new media to aid him in juxtaposing extremes in his pieces – electronics, synthesizers, etc., stimulating the imagination of the creator and opening up a world of timbral possibilities. Such music is always riddled with a certain amount of risk, as the aim of the experiment may be misguided. But, as rightly pointed out by Dorota Szwarcman, this music is focused not on finding universal solutions or inspiring aesthetic delight, but on asking questions and pointing out certain problems.[907]

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905 Mendyk, Topolski, *Krzysztof Knittel – interview…, p. 36.*

906 Knittel, commentary on the piece *dorikos*…, p. 183.

907 Szwarcman, *Czas Warszawskich Jesieni. O muzyce polskiej 1945–2007 [The Time of Warsaw Autumns. On Polish Music 1945–2007]*, Warszawa: Stentor, 2007, p. 53.

For Knittel, aesthetic values should be complemented by ethical values, hence the current of works with a message. The artist has not taken to dabbling in art for art's sake – underneath the outer layer of his works, a deeper meaning is always present – some kind of intuitive, living idea. He adds:

> To me, music is an individual manifestation of the freedom of the human spirit and should, as such, also be perceived in ethical terms. In my view, a composer and a musician cannot limit their approach to notions of beauty.[908]

At the centre of Knittel's interests lie multimedia projects: installations, performances, and all sorts of improvisational initiatives that hardly fit within the realm of serious music. Particularly close to the artist is also the desire to use art as a conduit for interaction with others, which is why he participates in many electroacoustic (both performance- and composition-related) collective projects. Free action in this regard sometimes takes the form of ludic japery. In many projects and compositions, the conceptual aspect is also important – it is the idea that is paramount. The *Sonatas*' creator never runs short on ideas – he is an active volcano of fresh, creative invention. As if to counteract this trait, Knittel often composes using 'ready-made elements' – all sorts of recordings and quotations from works by others and himself. He treats the use of self-quotations as a fully-fledged creative method, dubbing it 'musical recycling' (it may be included in the 'remix culture'[909]). This method has been widely used in, for example, *El maale rahamim…*, with most of the sound material having its source in other works.[910] In turn, the electronic part in *Sonata da camera No. 17* accompanying the organ sounds draws on *Surface en rotation*, a piece improvised by Knittel in 1997 and recorded on the French *Erratum #1* album, which was released by Erratum musical – revue sonore. The piece is used in its entirety and extends throughout the Sonata, thus it even determines its duration.

Knittel, known for his tendency to balance on the fringes and at the junction of many arts, penetrates the boundaries between 'reality and creation' and nature and art. This is why his work may

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908 Quoted in: Roemer, *Muzyka dźwięku i wydźwięku…*

909 See: Eduardo Navas, *Remix Theory: The Aesthetics of Sampling*, Springer, Wien—New York 2012.

910 *El maale rahamim…* features quotations from the score for *Lipps* for jazz trio and orchestra and String Quartet. In turn, the final passage of the score for *El maale* is quoted in *Saint Matthew Passion*, arranged for string orchestra.

come across as iconoclastic. Andrzej Chłopecki summed up Knittel succinctly – literally in three words – dubbing him an 'avant-garde, counter-cultural and alternative' artist'.[911] Krzysztof Droba, on the other hand, sees parallels with the attitude of Charles Ives, claiming that Knittel is a 'rebellious personality, but at the same time one based on a stable code of principles; an experimenter, who nevertheless adheres to a specific hierarchy of values in art; an individualist, but also social activist (devoid of artistic egocentrism – but full of concern for the social mission of art); a very serious artist – even when he indulges in games and shenanigans.'[912] One may also draw certain parallels with the approaches of John Cage (incorporation of all kinds of murmurs, clatters, and electronic sounds into the art, as well as improvisation), Mauricio Kagel (worded and graphic scores) and even Bogusław Schaeffer (elements of musical theatre).

Krzysztof Knittel is a musical experimenter *par excellence*, being one of Poland's most independent and original contemporary composers. He does not, however, see experimentalism as an end in itself – rather, it always goes hand in hand with an artistic sensibility that vividly reacts to the surrounding reality. On the one hand, he fully participates in Poland's musical life and is of great merit to it, while on the other, he remains an aesthetic outsider, following his own artistic paths.

3.5. Playing more than sounds – computer systems, performances, and installations by Marek Chołoniewski

Since the beginnings of his creative career, Marek Chołoniewski (b. 1953) was affiliated with the Academy of Music in Kraków: there, he studied (under Leszek Werner), music theory and composition (under Bogusław Schaeffer), and electronic composition (under Józef Patkowski). The latter field was by far the closest to his heart, which is why he has worked in the Electroacoustic Music Studio of his alma mater since 1976 and has been its head since 2000. In 2005, Chołoniewski founded the Polish Electroacoustic Music Association and continues to serve as its president.[913]

911 Chłopecki, *Muzyka naszych czasów…*

912 Krzysztof Droba, *Laudatio in honorem Christofori Knittel*, *Ruch Muzyczny* [Musical Movement], 2003, issue 22, p. 4.

913 The association became a section of The International Confederation of Electroacoustic Music. See: http://www.pseme.com/.

For Chołoniewski, performance and organisational activities are just as important as composing, as they are a certain kind of extension and culmination of the creative process. Having noted the need for a permanent contemporary music performance stage as early as 1977, he founded the 'Muzyka Centrum' Artistic Association[914] (remaining its artistic director to date), home to several performance ensembles related to contemporary music.[915] Between 1987 and 1992, Chołoniewski organised a series of 'Audio Art' concerts, which in 1993 evolved into an annual Festival[916] of international stature, pioneering the presentation of sound art. Chołoniewski remains its artistic director to date.

He usually participates in the implementation of his own projects, acting as a moderator and/or as one of the performers. However, his participation in performances does not involve traditional musical instruments, but rather computers, synthesizers, and other electronic media. In addition, Chołoniewski founded and co-founded a number of performance-based ensembles, including Pociąg Towarowy[917] (with Piotr Bikont and Krzysztof Knittel), CH&K&K[918] (with Krzysztof Knittel and Włodzimierz Kiniorski), mc2 duo (with Marcel Chyrzyński), and Kinetic Trio (with Włodzimierz Kiniorski and Rafał Mazur).

The novelty and idiosyncrasy of Chołoniewski's artistic endeavours, as a composer and a performer alike, pose a considerable challenge to those attempting to interpret them. Most of his projects (since the formulation 'musical piece' is oftentimes inadequate) transcend the confines of art – and not just sound art – extending it to media hitherto unheard of in music, such as the Internet, mobile telephony,

914 See: http://www.muzykacentrum.krakow.pl/pl/intro.html.

915 'Muzyka Centrum' is made up of creators and performers of contemporary music (e.g. Jan Pilch – percussion and composition; Kazimierz Pyzik – double bass, cello, viola da gamba, composition; Olga Szwajgier – soprano; Bogusław Schaeffer also collaborated with the group as a pianist). The association organises concerts, festivals, and workshops, records albums, and carries out outdoor and online multimedia projects. Ever since its inception, it has sought to use all the latest open art forms such as happenings, instrumental theatre, performances, graphic scores, and compositions using the latest technology: audiovisual and interactive projects. In the course of its career, spanning over three decades, the ensemble played several hundred concerts around the world.

916 See: http://www.audio.art.pl/.

917 See: http://www.towarowy.art.pl/.

918 See: http://www.cyfronet.krakow.pl/~zbcholon/chkk/.

or satellite navigation systems. By employing new means, this pioneer of Polish audio art aims to make his art interactive, interdisciplinary, and transcultural, or, simply put, universal.

Even among Chołoniewski's early works, one may distinguish experimental pieces such as *Citroblage reverse assemblage from prepared Zither* for solo headphones (1975), *Electronic Composition I* in the form of a graphic score (1975), and *Assemblages* – graphic music for specific performers and stereo tape (1975). As electronic equipment became more widely available in Poland, Chołoniewski's interest shifted to the electroacoustic music studio. As a result, he composed quite a few songs for tape in the late 1970s and early 1980s, including: *Red* (1975); *…blank…* (1976); *Process (for K.)* (1980); *La Cumparsita (hki 290880)* (1980); *Rag, Rag, Rag (1983)*; *The Same Fire for All* (1985). Of note are those projects where the sound space was also composed in through quadrophony: *a Beethoven-synthiblage* for 4-channel tape (1977), *Reflections for 4-channel tape* (1979).[919]

In the 1980s, Chołoniewski, fascinated by the sonic possibilities offered by electronic instruments, began to include synthesizers in the line-ups of his works, for example in *Cadence II* for viola da gamba, synthesizers and tapes (1983) and *Swinging Parameters* for oboe, violin, synthesizer and tape (1984). An even greater breakthrough was the use of the computer, which, starting with *Here and There* for piano, synthesizer and computer (1986), appears in almost all works by Chołoniewski and typically plays a key role in them.[920]

3.5.1. Electroacoustic translation – interactive systems

One of the main compositional issues that one may solve with the aid of a computer is the processing of all sorts of data into musical structures. Using an opportunely-written algorithm, one may control the sound layer with anything that can be parameterised and verbalised numerically – for instance, movement in a selected space, light intensity, or other sound layers. The data sources – the control layer – and the sound concretisations become coupled and interactive. For Chołoniewski, this interactivity has become the central creative idea, which is why he took to building tools for his own use that allow its ever-better implementation. In 1988, based on the Yamaha CX5M computer, he developed his interactive ATTS (Audio Time Triggering

919 Collective composition, co-authors: Magdalena Długosz, Bogdan Długosz, Tomasz Lida.

920 In 1987, he set up his private computer music studio based on a Yamaha CX5M portable music computer.

System), which 'is able to convert any acoustic impulses into a series of instructions for controlling the playback of computer music sequences.'[921] Soon afterwards, using of another computer – the Atari 1040ST – Chołoniewski developed the system's capabilities. Thus, the LTTS (Light Time Triggering System) was developed, in which computer control is integrated with light changes, came into being.

In the second half of the 1990s, the development of computer technology enabled the evolution of earlier concepts and made it possible to create a more innovative, open and multi-stage computer system that translates movement in an illuminated space into complex sound structures. The MCOS (Multi Controller Optical System) is made up of a set of optical sensors and with a custom-design interface. The system translates changes in light intensity into changes in sound structures, but 'the innovation of the MCOS compared to the ATTS system that I've used hitherto,' he writes, 'is that the performer, in their entirety, becomes an instrument in a virtual space, where not only single gestures, but the movements of the whole body, too, have a musical function.'[922] These new, interactive tools, or, rather 'musical instruments', have found their way into a number of different projects and compositions (cf. Table 4). In addition to creating new tools, Chołoniewski constantly uses and rebuilds ready-made software solutions; sometimes, he integrates them into new configurations, subordinated to the idea of the work. In *Like Breathing* (1991), for instance, he combined the interactive capabilities of the computer software called M and those of sequential processing of phrases and musical motifs offered by Cubase Score.

921 Chołoniewski, *Systemy interaktywne [Interactive Systems]*, http://www.studiomch.art.pl/.

922 Chołoniewski, *Systemy interaktywne…*

Table 4.
Interactive computer systems and projects using them

ATTS	LTTS	MCOS
Follow Me (1987) for voices, objects and computers ***Ears, Nose, Eyes*** (1988) – sound installation ***Follow Salzach*** (1988) – installation-performance ***Two Suns*** (1990) for instruments and computer ***Switched On***… (1990) for objects and computer ***Switched Off***… (1990) for instruments and computer ***River Dart*** (1995) for voices, strings and computer	***WYSYG*** (1989) for light and computer ***Beauty and the Beast*** (1992) for voice, light and computer ***Sha'ba del'mana*** (1994) – ballet ***Doubles*** (1993) for light, voices and computer ***River Dart*** (1995) for voices, strings and computer	***Lighting II*** (1997) for light and computer ***Dark&Light Zone*** (1999) – interactive audiovisual project ***Passage*** (2001) – interactive octet for instruments and computer system

In *River Dart* for voices and computer (1995),[923] Chołoniewski employed the ATTS system and rice sticks, which, by hitting specific spots on the desktop with the graphic score, generate the successive musical passages recorded in the computer's memory. These passages are mostly static and undergo a 'live' transformation as they swell and resonate. They are maintained in the spirit of ambient music, as they are characterised by a departure from the traditional elements of a piece in favour of a free composition of patches of sound. These measures are intended to result in the marginalisation of such elements of the piece as the succession of sounds or chords in favour of their sonority, spatiality, expression; hence, ambient music is perceived as static and outside of time. In the case of *River Dart*, the sound layer is built up by superimposing microtonal scales on glissando structures. These, however, remain deeply hidden in the broad spectrum of sound. They are composed to form an uninterrupted band of sound whose layers overlap and intertwine. This makes the musical aura of the piece dark and mysterious.

923 The piece was commissioned by Avantgarde Verein Tirol in 1995. The premiere performance was carried out by Olga Szwajgier and Chołoniewski at the opening of the 3rd Internationale Akademie für Neue Komposition in Schwaz, Austria.

The source of compositional inspiration and the word-and-sound material here is the final poem by Ingeborg Teuffenbach (1914–1992), with the same title as the work. The Austrian poet wrote *River Dart* for her son Fritjof Capra, a physicist and professor at California's Berkeley University. The musical layer refers to Capra's holistic philosophy, especially those contained in two texts: *The Tao of Physics* and *The Turning Point*.[924] Their author criticises the Newtonian-Cartesian thought paradigm, in which cognitive reductionism permits the understanding of the entirety of a given process by studying its parts (the *pars pro toto* principle). Chołoniewski symbolically demonstrates this in *River Dart* by splitting the text of the poem into pieces. The words, spoken in to the audience in an inaudible – but visually expressive – whisper, are subjected to transposition and temporal transformations (delays) before being mixed with a computerised sound layer. The text only becomes audible after a certain amount of time, in a subtly-processed form.

River Dart also exists in an extended version, with a group of stringed instruments led by a conductor reacting (with a slight delay) to the movement of a 'baton' – a rice stick. The result is a natural delay of the stringed instruments in relation to the electronics (the computer system reacts to the movement and strokes of the baton immediately, while the strings receive signals from the conductor with a certain delay). The de-synchronisation of the two instrument groups is a conscious compositional measure. The effect is similar to the process of voice transformation, both when it comes to the sonic and the visual. In the commentary, Chołoniewski emphasises that 'what we see is not always what we hear (!) *(What You See Is Not Always What You Get) – WYSINAWYG (!?!)*'.[925]

3.5.2. Hypermedial objects – sculptures, installations and sound environments

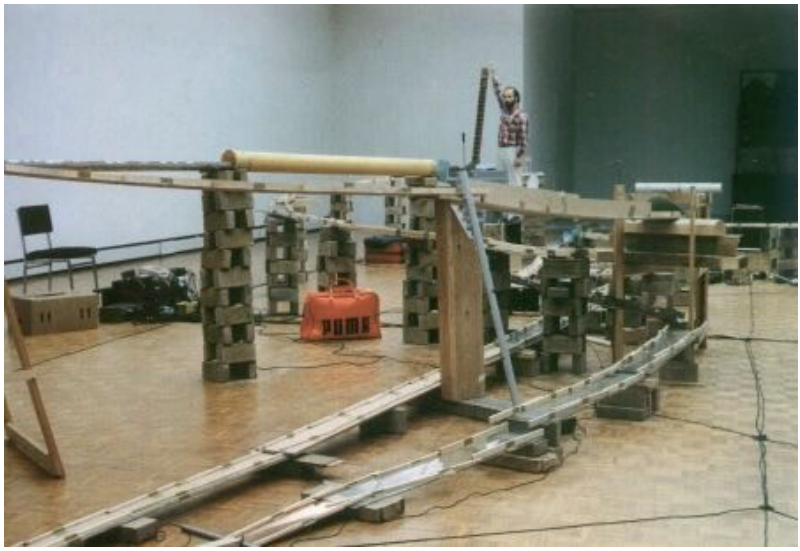
E a r s , N o s e , E y e s is a joint project by Chołoniewski and Marek Chlanda created in 1988, commissioned by the De Fabriek gallery in Eindhoven.[926] Chlanda, a sculptor, printmaker, and performer, built a spatial sculpture-installation for the project according to his own idea, made of bricks, tin, and cardboard tubes and other

924 *The Turning Point* posits that physics and metaphysics inevitably lead to the same knowledge.

925 Chołoniewski, commentary on *River Dart*, http://www.studiomch.art.pl/marek.html (access: 21 July 2014).

926 The project was also shown at the Audio Art Festival in The Hague in 1989.

materials. The appositely-connected elements resembled a maze or a rollercoaster mock-up, with several hundred glass balls moving around it. By attaching 40 contact microphones to various parts of it, capturing the sound of the balls' movement, Chołoniewski turned the sculpture into a musical instrument of sorts. Through computer processing, they are multiplied, coloured, and spatialised in various ways. The balls in the middle trigger another part of the system: the dripping of water onto heated wax, which produces additional aroma effects. Thus, the installation affects multiple senses simultaneously, becoming multimedial and polysensory par excellence.



Example 69. The *Ears, Nose, Eyes* installation (Audio Art Festival in The Hague, 1989)

Here, the visual aspect – shape, material – is no less important than the sounds, which is why the project's form may be described as a sound installation. This installation refers to the various noise machines built by the Futurists (cf. Chapter 1.5). Russolo himself saw the 'art of noises' as a pathway for the development of new music, which he expressed in his artistic manifesto. Chołoniewski, however, did not merely aim for finding 'beauty in noise', but about visualising sound and playing with it. After all, *Ears, Nose, Eyes* is reminiscent of a child's jigsaw puzzle, magnified to enormous proportions, or intricate structures built from matchsticks.

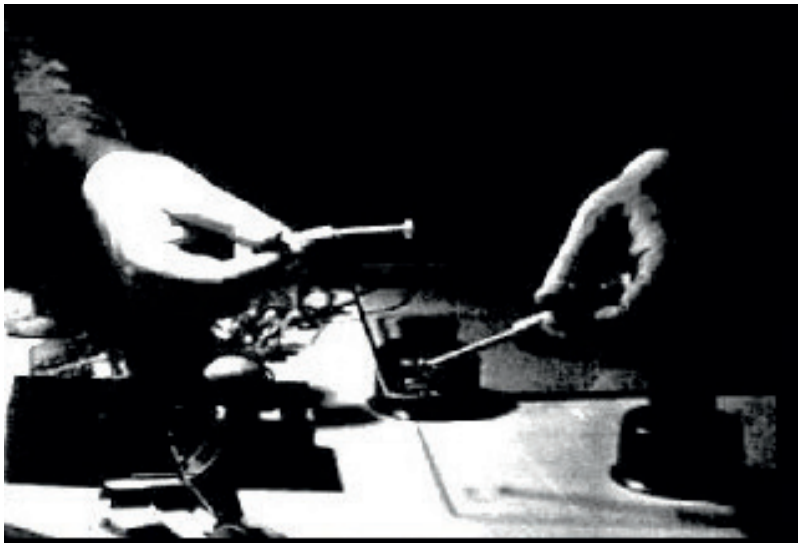
Switched On... and *Switched Off...* are audiovisual projects using installation and performance elements. (1990). Both were commissioned in 1989 and premiered in December of the same year, at a concert at the Kunst Museum in Bern as part of the Ton Art Festival.

For the audience of *Switched On...*,[927] the visible component is a table laden with all sorts of objects that become the 'characters' of the puppet play. A set of contact microphones converts (via the ATTS system) the noises created within the table into instructions controlling the various elements of the musical layer. This layer consists of easily recognisable quotations, phrases, motifs taken from classical music (including from Mozart and Chopin), but also from symbols belonging to different cultural circles (sounds of ethnic instruments, Far Eastern scales). The music concretises the visible and, by presenting familiar and recognisable quotations, creates paradoxical meanings for theatrical situations. This is because all the movements within the mini-theatre create a certain kind of musical illustration. The visual layer of the composition is a material, physically-existent, and tangible reality, in contrast to the abstract and ephemeral sound layer. The beholder is able to follow how these spheres interact. The title *Switched On...* refers to the way sounds are generated and music is created – the movement of the objects on the table quite literally 'switches on' certain sound structures.

Switched Off..., on the other hand, reverses this principle. Here, the starting point here are self-growing and fluctuating sound bands with a fixed spectral-harmonic structure. The performers attempt to disrupt this band with single notes performed on a ceramic flute and a mouth organ. Each time a sound band is interrupted, it automatically generates another band of a different structure, depending on the pitch of the sound produced by the acoustic instrument.

The installation *Hypermeable Objects* (1996) was commissioned by the Austrian Avantgarde association. It is an elaborate interactive and audiovisual project bearing characteristics of the sound environment genre, created in collaboration with Rens Veldman. The presentation of *Hypermeable Objects* at Stadt Galerie in Schwaz involved three separate sound installations. The first, performative – 'internal ambient' – depicted pins being stuck into a row of eight potatoes lying on the floor. This activity triggered the

927 An important reference to note is the allusion to the famous album by Wendy Carlos, *Switched-on Bach*.



Example 70. The performative activities in *Switched On…*

playback of pre-recorded short texts, intended to give one the impression that the vegetables were talking. The potatoes are begging for mercy and expressing their opposition to the violence being inflicted upon them – after all, they are being pierced with pins. An eccentric 'vegetable monologue' plays from a row of speakers set up nearby. These, in turn, have their diaphragms directed towards the ceiling and are covered with tin lids on which foodstuffs – flour, rice, salt, sugar, groats, and poppy seeds – are scattered. The vibration of the speakers' diaphragms caused these loose products to form moving, symmetrical reliefs on the lids, reminiscent of cymatic visuals.

The second part of the installation – the 'external ambient' – was located in another room and involved household appliances – a hoover, a juicer, a hairdryer, a bedside lamp, and a radio. These were intended to become musical instruments of sorts, forming an ensemble. The power supply of the 'instruments' was connected to an interactive optical system, reacting to the movement of the people in the room. The computer controlling the system sent rhythmic electrical impulses for switching individual devices on and off, giving the audience the ability to consciously control (conduct?) the performance of the entire ensemble.

The third element of the project was situated in the gallery corridor, where a piece of paper containing a text printed in a very small font was hung on a white wall. One could only read it by stepping onto

an electronic scale near the wall and using a lens hanging nearby. The scales triggered the playback of the recorded texts, which reused the texts 'spoken' by the interactive potatoes.

Watching the 'talking potatoes' and self-starting household appliances in the gallery might cause consternation at first. To interactors, *Hypermeable Objects* may come across as a kind of large-scale, interactive toy. The creator, meanwhile, points out that 'one of the project's basic intentions was to link semantically related and opposed elements'.[928] According to the composer, the title refers to the biological processes taking place between groups of cells. One may also notice some play on words in the title – the word 'permeable' contained in the title describes each of the installation's hypermedia objects.

3.5.3. Light-sounds – audiovisual performances

In *W Y S Y G* (1989), for the first time, Chołoniewski combined two abstract energies intermedially – light and sound. He reveals that the key to reading his artistic intentions is the acronym *WYSYG (What You See You Get)*, as the light figures in the piece are directly translated into musical phrases. Quite literally, 'what you see is what you hear'.[929] The performance takes place in a dark room. The performer operates a small lamp directed at themselves, with its light picked up by a system of optical sensors attached to the performer's head (neck, ears, mouth). Each sensor converts the exposure levels into a data stream which, in turn, controls an independently selected parameter of a pre-prepared score stored in the computer's memory. To put it in more general terms: the performer's movements conduct the music using light, which influences elements, such as the duration of sound structures (through the frequency of the performer opening their mouth), changes in timbre (through the level of illumination of the performer's neck), or position within the sound space (through the stream of light directed at the sensors placed near the performer's ears).

928 Chołoniewski, *Multimedia*…, p. 313.

929 'WYSYG' is an acronym used in computer science to describe methods that produce a result identical to what one sees on the screen. Software meeting such assumptions presents data (text, graphics) on a computer monitor in a manner as close as possible to that obtained when printed or otherwise transposed into a physical form.

The continuation of *WYSYG*'s concept is found in audiovisual projects *Lighting* (1995) and *Lighting II* (1997) for light and computer.[930]

The composer himself calls them 'interactive sound spaces'. They are 'armed' with various types of sensors that respond to movement, which impacts light intensity. As in *WYSYG*, the movement affects changes in sound structures.

The acoustic dimension of the performance *D o u b l e s* for voice, light and computer (1993) exploits a certain kind of stylistic dissonance. Here, different qualities are juxtaposed: recognisable, tonal and 'logical' sound material with synthetic sounds and aleatoric structuring, and classical-romantic and folk stylings with atonal abstractionism. The author employs a number of electronic tools, including the ATTS system and an effects processor that converts the sound of the human voice. In the commentary on *Doubles*, Chołoniewski points out that the possibilities of new media bring great inspiration, but at the same time shape the composer's creative thought through limitation of these possibilities. There is a certain relationship between the composer and the 'composed material' – a feedback loop of sorts. This relationship also occurs when an author quotes or transforms musical material by another composer:

> To what extent may one impact the recognisability of a work of art, a musical piece? Where does one draw the line between the original and its processed form? When one performs a piece by Chopin on an instrument other than the piano, they are making a transcription, but when they create an artistic development suitable for the character of the other instrument… When one continues to work on that piece, completely surrendering to the nature of that instrument, does this mean creating a new composition? How does one capture the moment when the source piece becomes the inspiration for a new, original composition?[931]

Thus, with this piece, Chołoniewski asks the question whether a new form of music is already created through the integration of various cultural, historical and social elements.

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930 The author also states the line-up: 'for instruments, voices and computer interactive systems'.

931 Chołoniewski, commentary on the piece Doubles [in:] *Warszawska Jesień '94. 37. Międzynarodowy Festiwal Muzyki Współczesnej, 15–24 września [Warsaw Autumn '94. 37th International Festival of Contemporary Music, 15–24 September 1994]*, [programme book], p. 172.

In subsequent 'light-sound' performances, Chołoniewski increasingly combines electronics with a 'live' performance ensemble, e.g. in *Dark&Light Zone* – an interactive project for string quartet, ballet and soloists (1999) commissioned by Avantgarde Schwaz for the London-based quartet Arditti. Later, versions were created under the same title, written for solo performance (by the composer himself), then for the dance troupe Compagnie Stanisław Wiśniewski from Lyon, as well as an interactive installation available to the public at London's IMT gallery.

The piece may be divided into four parts-phases, with different types of interaction taking place between the 'live' instrumentalists and the computer. In the first movement, the quartet reads a graphic score being drawn up in real time, projected onto a large screen. The score contains a series of pre-catalogued signs corresponding to the various formal elements of the music being performed, including: dynamics, articulation, intonation, tempo, etc. The graphics are created in real time in OvalTune, then displayed on a screen divided into four sections corresponding to the respective instruments of the quartet.



Example 71. The graphic score created during the premiere of the composition *Dark&Light Zone*

Then the musicians, now without their instruments, move to the centre of the stage, where they perform in an interactive space, controlling the computer sound system using their gestures. Then, specially prepared and computer-integrated bows (with miniature light bulbs and a microphone attached) generate dynamic abstract images on the screen with their movements. The graphics are controlled through acoustic cues, derived from murmurs, knocks, and other sounds produced by the individual instruments of the string quartet.

In the final phase of the piece, the musicians play while standing and moving their instruments against the immobile bows (the cellist balances his instrument in a pendulum-like manner). The quartet thus performs the first four chords from *Moro lasso* by Gesualdo da Venosa. The musicians repeat the first four chords from the famous motet, slowly moving the end of the bow with the bulb towards their faces. Everything takes place in complete darkness, with only four stationary points of light visible: four miniature light bulbs attached to the end of the strings. In addition, Chołoniewski programmed the computer system in such a manner that the volume of the sound depended on the intensity of the light. The lights only illuminate the performers' faces, which slowly emerge from the darkness and disappear into it at the end of the last section. In the initial phase, the strings are stationary; with later repetitions of the chords from the *Moro lasso*, the strings create luminous drawings in the darkness, closely linked to the ornamentation of the underlying musical material. The point of reference and the primary opportunity to control the manner of articulation is the position and movement of the glowing end of the bow.

As the name implies, *Dark&Light Zone* is based on the opposition between light and darkness, interplaying with the opposition of sound and silence via a computer. Another form of linking the gesture with its visual and musical equivalent are the geometric figures drawn in darkness. In the last part of the piece, a specially prepared instrument – a light bow – can be used to further enhance the audiovisual qualities of the composition. *Dark&Light Zone* exists in two versions: as an audiovisual performance and as a spatial installation open to the public.

Interactive play with light can also be found in the audiovisual project *F a c e*, which Chołoniewski created in 2000, during his stay at the State University (North Arizona University) in Tempe. The essence of the piece is a performance during which the performer holds a small camera in one hand (with the image projected onto a large screen) and

a lamp in the other. The tools in the performer's hands are to be used in such a way that they show that person's face in a variety of ways. The resulting image transformations create a slow transformation of the performer's face. The project was executed in several versions, as a performance, but also as an interactive video installation. As was the case with *Lighting II*, the project was also built as an interactive instrument and installation accessible to a single viewer, who, sitting in an armchair set in the middle of a completely darkened room, triggered the processing of their face on a large screen. In 2002, Chołoniewski created an extended variant of this project, *Face 2*.

WYSYG, *Lighting*, *Lighting II*, *Face*, and *Face 2* continue the same idea. Chołoniewski creates sophisticated forms of translating the performer's facial expression and movements of the performer in a dedicated space into a structure of an elaborate audiovisual composition created in real time. One might call this project series interactive sound portraits.

The composer's performative site-specific installations include the unfinished project, *G a r a g e* (2000). It entails using the entrance to an underground garage; members of a large instrumental ensemble would be positioned at the corners. Each musician's playing is relayed in real time to a transmission truck, which subsequently mixes the sounds and transmits them via a local radio channel, so that the mix may be heard in vehicles equipped with receivers. The car's lighting, on the other hand, directly influences the volume of the individual instruments via a light sensor system.

Chołoniewski utilised the play between light and darkness in the piece *Almost Nothing* for an ensemble (2007). The piece was premiered by Muzyka Centrum at Villa Decius in Kraków:

> …it was a combination of exhibition and sound installation. People are passing by, visiting. Here, someone is playing, there, the music is dripping by itself. It's noisy everywhere. In the final room – darkness. All of a sudden, the lights come on, and the musicians may be seen, frozen in stillness. Then again, all of a sudden, darkness and noise – lots of movement, murmurs. This is what my piece *Almost Nothing* is like. This 'almost' is the noise in the dark, the impact on the audience's perception.[932]

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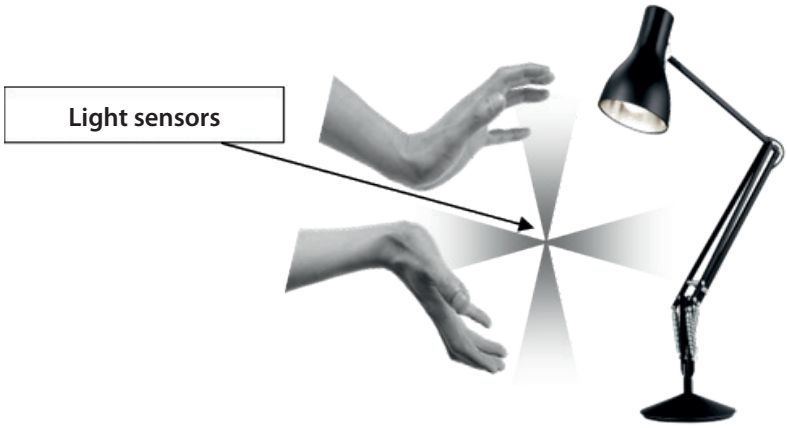
932 Chołoniewski, quoted in: Krzysztof Cyran, S*iedem odsłon Marka Chołoniewskiego [The Seven Faces of Marek Chołoniewski]*, http://www.polskamuza.eu/siedemodslon_archiwum.php?id=108.

3.5.4. Gesture-sounds – interactive scores

One of the most important performances by Chołoniewski is *Passage* for instrumental octet and interactive computer system (2001). The line-up here is a combination of two quartets: woodwind (flute, oboe, clarinet, and bassoon) and string (violin, viola, cello, double bass).[933] All of their actions are directed by Chołoniewski. The composer distinguishes four parts of the project: *Introduction*, *Theatre of Gestures*, *Score*, and *Film*.

Introduction serves to present *Passage* and the 'rules of the game' to the performers and listeners. The second part is a 'silent' performance in which the performers' hand movements are coupled with an algorithm that generates the score material for the later parts of the piece via an interactive system. Each musician shapes their part independently, but simultaneously with the other members of the ensemble. It is an improvisation conducted by Chołoniewski – each finger of his hand is assigned to the hand of one performer. The movements of individual fingers determine the 'solo parts' of the individual musicians, the movements of the whole hand conduct the quartet, and the movements of both hands direct the whole ensemble. The performers' desks are fitted with motion sensors.



Example 72. Illustration of the operation of the gesture-light-data system in the second part of *Passage*

933 This line-up was dictated by the technical possibilities of the interactive computer system that Chołoniewski had at his disposal during the premiere of *Passage* at the 'Warsaw Autumn' festival in 2001. In 2013, he wrote a new patch that allows a larger line-up of up to several dozen people.

Each of the performers has a dedicated space that, owing to the optical system, is sensitive to changes in light over time. A computer program enters them into the system as a series of numerical strings, and then converts them into information encoded using the MIDI protocol. This software is linked with a score editor 'translating'[934] numerical gesture sequences into notes placed on staves, using 21 scales selected by the composer, including whole-tone and pentatonic. Although the choice of sound scales has an impact on the harmony, the end result of a composition created in this way is largely unpredictable. The whole mechanism is intuitive – when the performers' hands move closer to the light source, higher tones are generated, and when they move away from the light, lower tones are generated, while the absence of movement generates a pause. Thus, the computer responds to the geometric figures drawn in the air by the performer (physical gestures) by producing strings of sound-notes (musical gestures). And this is how the title transition is carried out.

In the third part, the generated score is displayed on small monitors in front of the performers, and presented to the audience on a screen situated above the stage. The performance of the resulting score is quite a challenge for the musicians, as this is the first time they see their parts. Reading notes a vista may be done with the aid of the conductor or the headphone system, in which the pulse (known as the click) of the metronome can be heard. A vertical line appears on-screen, moving across the score to indicate the current bar measure. Thus, the musicians premiere the score that has just been generated. The composer does not stop there – the actions of the musicians, namely the movement of the instruments and the changes of the performers' positions are interactively coupled with electronic sound processing as well.[935] The final, fourth part of the piece takes the form of an audiovisual performance, in which the interactive transformation of instrumental sounds is accompanied by an interactive video projection, which the composer creates live using a webcam attached to a long support stand.

In *Passage*, Chołoniewski radically changes the rules of the traditional compositional process. In a certain sense, the music here is created by the performers themselves, 'setting in motion' the

934 During the premiere, Finale software was used.

935 Chołoniewski, commentary on the piece *Passage* [in:] *Warszawska Jesień '01. 44. Międzynarodowy Festiwal Muzyki Współczesnej, 21–29 września 2001 [Warsaw Autumn '01. 44th International Festival of Contemporary Music, 21–29 Autumn 2001*, [programme book], p. 133.

composer's algorithms. The performance is a form of controlled process in which the creator only designs the compositional process itself. Thus, *Passage* is not about the aesthetic aspect of music, but about public, collective participation in the process of creating a work. The sound language and form of the piece depend on its author to a degree different than with traditional composition. Thus the creator relinquishes responsibility for the sonic shape of his work, does not have to identify with any style or convention, and escapes the beaten path of his own thoughts. What is more, a different composition is created each time, despite a fixed algorithm for creation being in place.

Performing a piece requires a considerable amount of not just work, but also resources, as, in addition to the performers, monitors, one needs coupled, interactive computer and optical systems. Paradoxically, however, *Passage* was also performed under the (somewhat ironic) title *Cokolwiek innego bez elektroniki [Anything Else Without Electronics]*,[936] for, despite the use of sophisticated computer and interactive systems, the composition does not contain any electronic sounds – only acoustic. Chołoniewski wanted the technology used in it to be hidden and unobtrusive. Rather, the focus of observation was to be on the creative act itself, which is, one might say, 'laid bare' here, explained and shown to the audience step by step. The music is created before the audience's eyes, 'out of nothing' and 'into nothing' – following each performance, the temporary score of the piece is erased.

3.5.5. Sound on the web – audio net art

The series of projects by Chołoniewski incorporating the web into art media began with *G l o b a l M i x* from 1998. It is not a typical musical composition, but an indefinite work in progress. Chołoniewski initiated it by sending out an electronic request to participate in a group online composition by submitting any sound material he had developed to a number of artists around the world. The invitation was accompanied by information that the audio file must be no shorter than one second and no longer than three minutes, and that the sender waived copyright in the submitted file, which was to become public domain. A number of artists responded to the request, especially composers of electroacoustic music and friends of Chołoniewski (including Lidia Zielińska, Marcel Chyrzyński, and Zbigniew Karkowski).

936 In subsequent years, the work was performed (under the same title) without line-up restrictions as an 'interactive score for ensemble (2001–2003)'.

Owing to its entirely open form, GlobalMix is an ever-growing collection (database, library) of miniature music compositions and sound objects. It is currently made up of around 150 different files. This collection may be used in a variety of ways, both by the initiator – Chołoniewski – and by others, given that:

> All of the uploaded material is available on the *GlobalMix* homepage for all internet users and others. They will be able to create their own composition-mixes.
> *GlobalMix* challenges all authors to become part of a collective creativity, without the constraints of copyright law. The publishing rights at *GlobalMix* are in the public domain. All of the materials submitted to the *GlobalMix* homepage may be used in whole or in any part. The components of *GlobalMix* may be subjected to any kind of processing, transformation and manipulation for compositional, editorial, theoretical, analytical, musicological, research, and other aims, and may be used in any way for commercial and non-commercial purposes.[937]

In 1998, *GlobalMix* was presented and performed as a 'mixed' electroacoustic composition at the Audio Art Festival in Kraków. Following this, the composer decided to expand the range of submittable material to include graphics, computer animation and films; thus, in 1999, *GlobalMix 2* became an audiovisual creation.

As a collective project in the form of a completely open web site, it is close to both the ideas of conceptual and web-based art, and those of net art. The reception of such works is specific, as it involves going to a relevant web address on the web, then navigating through the site. The interaction with the project may then take place in a variety of ways, engaging and triggering a multitude of senses and values. In the words of Ryszard Kluszczyński, this kind of work:

> Exists in the form of a visual (potentially audiovisual) hypertext: a form that is complex and multi-layered, awaiting our participation. Thus, the perception of a work located on a computer network takes the form of interactive navigation through its virtual dimensions.[938]

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937 Chołoniewski, *Ograniczenia, wykonania i publikacje [Limitations, Performances and Publications]* (chapter) [in:] *Marek Chołoniewski Global Mix (1998) zbiorowa kompozycja internetowa [Marek Chołoniewski Global Mix (1998) Collective Web Composition]*, http://globalmix.studiomch.art.pl.

938 Kluszczyński, *Internet – nowe terytorium ekspresji*…

GlobalMix may indeed be regarded as a musical hypertext of sorts, a 'sound stack' that may (and should) be navigated non-linearly. The files are ready-made components for use in potential compositions: they are multimedia puzzles from which anyone may assemble their own piece.

3.5.6. Telematics and geolocalisation – GPS-art

Initiated in 2000, the project *The Ship of Artists* remained an artistic utopia; it was never completed. This original project-manifesto combines the characteristics of a concert, an installation and a cruise, with the ship becoming an interactive sound medium of the natural surroundings. The composition consists of three parts defined by three stages of a cruise along the Vistula: Kraków – Sandomierz – Kazimierz Dolny – Warsaw. The titular vessel is equipped with a variety of sensors continuously registering a number of physical parameters of the environment: the distance between the vessel and the shores and the bottom, the water temperature, the speed of the wind, as well as the amount of light during day and night time. These parameters – in the form of numerical sequences – control the system for processing the sonic structures collected in real time from the ship's surroundings. A specially prepared booth equipped with an audiovisual system for continuous projection is used for this end.[939] Thus, the changing environment is reflected in the sound structures created live aboard the ship.[940] Chołoniewski admits that he has always been interested in the following kind of setting:

> An outdoor work, that I know from doing installations and performances in open space; I am especially interested in movement in and of itself – manoeuvres in space that cause musical reactions, but also, very importantly, generating and processing images obtained using the camera.[941]

939 Chołoniewski, quoted in: Marietta Morawska-Büngeler, *Dusza dźwięków [The Soul of Sounds]*, http://www.pseme.com.

940 Although this project may seem quite innovative and original, similar 'musical ships', though not associated with serious music, but with jazz, were sailing on the Mississippi at the turn of the 20th century already. At the time, they were called 'jazz academies'. They hosted numerous concerts, musical duels between improvising virtuosos, and a platform for the exchange of experiences and artistic views. These ships travelled between distant cities, where different styles of music were popular – the performers tended to adjust to them. Thus, the environment influenced the music played on board. With the new media, Chołoniewski managed to achieve a similar situation, but on completely different terms.

941 Chołoniewski in an *interview with Łukasz Guzek*, XII 2000 [composer's materials, unpublished].

In December 2000, Chołoniewski, together with Marcin Wierzbicki, Ryan Ingebritsen and Jan Chołoniewski, created the telematics project *GPS-Art*. As the name suggests, it employs a satellite navigation system used, among other things, in cars, and assumes the form of a series of interactive musical performances, broadcast online as *G P S – T r a n s*. Their implementation entails designing computer audio systems so that they may be controlled using a stream of digital data produced by an operational GPS device.

The first project of the *GPS-Trans 1* series was implemented at the end of 2000, assuming the form of a twelve-hour open webcast (divided into four 3-hour blocks), as part of a larger, international project.[942] Here, the musical material was a multi-level transmission from sixteen mobile phones set up in conference mode and acting as transmitters, relaying sounds from different areas of the city to the studio. These sounds were mixed in the studio and sent over the Internet, with their loops creating a growing 'sound wave' (Chołoniewski called these sound collection, and the layering sound techniques are called *Internet Delay* and *Internet Loop*). The broadcast went 'live' and was available to everyone. Chołoniewski commented on the principles of the technical solutions employed in the first implementation as follows: 'the voices would be lost, overlapping, with no indication of time or space, but it was nevertheless quite interesting when it came to the musical structure. People who didn't know or recognise one another spoke at the same time.'[943]

Chołoniewski explored the possibilities of translating movement interactively into music for a long time. *GPS-Art* is an extension of this idea, taking it from the enclosed space of a concert hall (or gallery) to a global scale. In addition, projects utilising online data transmission, such as *GlobalMix* and *GPS-Trans*, treat copyright legislation in a particular kind of way.

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942 In 2000, Łukasz Guzek and Efka Szczyrek (with technical assistance provided by Jacek Rogowski and Jack Judah) initiated the online project *Cafe9* in Kraków. It was made up of net-art works by artists, such as Artur Tajber, Marek Chołoniewski, Anna Janczyszyn, Barbara Maroń, Jennifer De Felice. It was available online to everyone, and was also presented on one computer in the bookshop at the Bunkier Sztuki gallery. The project ended in 2001.

943 Chołoniewski, *Sztuka dźwiękowa – mediacja intermedialna [Sound Art – Intermedial Mediation]*, p. 13, http://www.medialarts.pl/download/kadra/skrypty/interakcje/sztuka-dzwieku.pdf.

> The author said: 'This is like opening a door, we are entering an area of public broadcasting that was hitherto strictly controlled and reserved for such institutions as radio or TV. On the Internet, we are not bound by such regulations and restrictions. (…) There are few such endeavours in Poland, and this space is, after all, accessible to all. We have mastered the web, using it for specific artistic purposes, opening up completely new perspectives.[944]

This allowed the creation of an original, urbanistic audiovisual composition, designed in synchronous, mirrored, embedded audio and video projection spaces.

GPS-Trans 2 was implemented in 2001. At the time, the interactive score for the project was a map of Kraków,[945] and the 'performer' was a car with a GPS-Phone system installed, cruising the streets of the city. As the car moved, the data sent by the GPS system (geographical location, speed, etc.) was recorded, then filtered and processed by a portable computer, then further transmitted wirelessly to a server via a mobile phone. The transfer of data triggered pre-recorded sounds from 41 selected areas of the city, which were presented to the public at Bunkier Sztuki in Kraków during the premiere and broadcast live over the Internet. Thus, the vibrant city became an interactive art space – a huge multimedia instrument.

Another implementation within the framework of the *GPS-Art* project followed similar principles, but with an accompanying series of slides controlled by the live speed of the car; *GPS-Trans 3* was presented in 2002 as part of William Duckworth's larger international project *Cathedral*. In 2003, there was a fundamental change to the form of the implementation of the successive iterations of the project. The Internet, being the main stage for the activities presented, turned into a concrete public space. *GPS-Trans 4*, an audiovisual spectacle featuring a band and a dancer, was performed at Kraków's Krzysztofory Gallery. The car was equipped with a system featuring four video cameras capturing quadraphonic images of the city. The video footage thus recorded was then prepared for projection onto four screens set up in a square shape, which resulted in an illusion of being inside the car, with images of the city projected on its 'windows'. The quadroscopic and quadrophonic projection field delineated the space

944 Chołoniewski, *Sztuka dźwiękowa…*, pp. 13–14.

945 As early as 1981, Larry Austin composed *Canadian Coastlines*, where he translated the map of Canada into musical texture, rhythm, and melodic structures.

of both performance and reception of the work. The audience was invited inside the square with the possibility to leave and return to the inside of the projection and sound field. Moreover, the visual layer was mixed with sound material transmitted via the Internet from Chicago, extending the work's formula to include elements of network (bridging two continents), performance, and concert art.

In *GPS-Trans 5* (2005), the car was moving around the city of Luxembourg, and the transmission was visible to an audience gathered at the Bunkier Sztuki gallery in Kraków. *GPS-Trans 6* was presented at the Ujazdowski Castle Centre for Contemporary Art in Warsaw (2005), and *GPS-Trans 7* was presented at Chicago's Deadtech Gallery (2007). *GPS-Trans 8* (2007) was planned on a larger scale, as its implementation entailed the coordination of four cars driving simultaneously in Chicago, Luxembourg, Warsaw and Kraków, simultaneously transmitting four audiovisual signals. They were mixed and projected at the Bunkier Sztuki gallery in Kraków, where – as was the case with previous productions – the performance was extended to include improvising musicians and a dancer. *GPS-Trans 9* and *10* were implemented in 2009 at the Solvay Centre for Contemporary Art in Kraków and online, mixing several European cities simultaneously (Prague, Banská Bystrica, Berlin, Budapest).

GPS-Trans 11, subtitled *Pécs D(é)RIVE*, became a joint project between Chołoniewski and the European Bridges Ensemble. The premiere took place in 2010, at the University of Pécs in Hungary. The car recreated the pre-planned route by sending its GPS coordinates, which in turn controlled the playback of the recorded audiovisual material on four screens and through a quadraphonic system. The locations of the recordings were selected according to the particularities of the respective sound environments, which is why mines, the tallest empty buildings and a TV tower, among others, were filmed. The structure of the piece was a series of solo audiovisual compositions by individual members of the EBE ensemble, as well as interludes of sorts performed by the car based on urban material. This is how a dialogue was created between the live-controlled sounds of the city and the author's compositions dedicated to selected areas of the city of Pécs.

These projects are part of a new field of art – GPS-art. They are based on geolocalisation of movement in open places – on land, in the air, underwater and even in space.[946] The peculiarity of *GPS-Art*

946 This is the way in which, for instance, gigantic virtual paintings are created by the Kraków-based artist, Krzysztof Mazur. See: http://www.gpsart.eu/.

lies in the use of the city as an audiovisual instrument, the city map serving as the score for a live performance of the composition, and the moving car with GPS as the performer of the piece. In this work, the city space is used not merely as a real urban sonic and visual space, but also as a virtual labyrinth – a postmodern rhizome.

According to Murray Schafer, modern cities are teeming with sound, making the acoustic environment of modern man 'polluted'.[947] This is not so much due to the presence of noise in cities, but to a certain factor leading to it: the acquiescence to the absolute primacy of visual perception, which inhibits sensitivity to sound.[948] The projects of the *GPS-Art* series enable a new perception of the city soundscape. Participating in their implementation gives one the impression of going on a virtual tour of the city, a telematic discovery of its sonic climate, and the possibility embarking on a virtual sound journey.

Global Terrrain (2007)[949] is a three-dimensional, interactive audiovisual installation that creates a spherical projection of a world map with highlighted fields (points) representing all of the existing countries. The dots representing the countries are parts of a moving multi-dimensional puzzle, outlined on a mock-up of a giant globe. The map becomes an interactive instrument, generating a variety of audio and visual abstracts (symbols, icons) related to the culture and history of the respective countries. Taking into account the technical possibilities, the *Global Terrain* installation may be presented in two versions. The first entails displaying an interactive map of the Earth on a translucent spherical projection space with a diagonal of 18 metres. The sphere's entrance should be situated at the bottom point matching the actual place on the world map where the installation is currently presented. This creates a symbolic transition between the real world and its size-reduced virtual mock-up. In the centre of the sphere, the interactor is to be situated on a platform from which they are able point to locations on the map. Pointing a finger at any location on the map opens the video feed of one of the several hundred network cameras broadcasting live images of the location.

947 Schafer, *Muzyka środowiska*…, pp. 288–315. This opinion was shared by Witold Lutosławski, who, as a member of the UNESCO International Music Council, was one of the initiators of a resolution adopted in 1969, condemning the violation of personal freedom and everyone's right to silence.

948 Kapelański, *Mała historia ekologii akustycznej (1967–2005)*…

949 From a purely sonic perspective, *Global Terrain* is a continuation of earlier projects, especially the composition *The Same Fire For All* (1985), which employed musical symbols from different corners of the world (including the Pythagorean temperament and Indonesian scales).

Then, the *Global Terrain* map becomes an interactive audiovisual score available to the interactor, who, in turn, becomes a 'conductor' of instrument-states transmitting live texts, videos, graphics, sounds and passages from musical pieces specific to the region. The underlying idea of the installation is to enable the juxtaposition and combination of various, sometimes very distant traditions and cultures, giving one the opportunity to (re)configure them without limit, but also to juxtapose them for comparison. The interactor has complete freedom when it comes to shaping these cultural fusions, both in the choice of material and its geographical scale.

In a simplified version of the installation, the map is displayed on a floor plane that reacts to the size of the covered area. The generated audiovisual material is presented on four screens, situated on the walls of the room. The spatiality of the transmission of the audiovisual structures is ensured by a quadraphonic loudspeaker system. The composer also allows the possibility of installing four hanging screens in the centre of the gallery (along the lines of the four-sided *GPS-Trans 4* projection).[950]

Global Terrain is a visionary, futuristic multimedia project, but also a multifaceted geographical and historical grid of references: According to the creator, the interaction between the visual and aural space in the *Global Terrain* project, consists of the following:

> The simultaneous superimposition of elements that are real, far from reality, and entirely fictional, but are nevertheless in a metaphysical relationship with the momentary order of the world and its constant mutability, the order of their essence, and movement in a multidimensional curved space-time.[951]

By combining audiovisual, spatial, and network means, Chołoniewski creates a musical-visual interactive globe, doubling as an immersive meta-instrument of unprecedented scale.

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Chołoniewski champions the idea of breaking with tradition and pursuing one's own original idea of art. He prefers to pave new artistic paths rather than tread those already trodden. He is not a typical

950 In this form, *Global Terrain* may resemble the interactive video panorama *Landscape One* (1997) by Luc Courchesne.

951 Chołoniewski, commentary on *Global Terrain*, http://www.emd.pl/wiki/Marek_ Cho%C5%82oniewski (access: 21 July 2014).

composer, and does not create pieces in the traditional sense of the word – he is an audio-artist and performer for whom music is only part of the very broadly defined field of sound art.

The strategies and techniques employed by him are sometimes close to the ideas of inter-media collage. Indeed, the creator juxtaposes elements and media that are completely alien to one another, in a certain sense forcing their interaction. The sense and significance of such works is not planned by the author; instead, they reveal themselves the moment the work is implemented. In this field of art, the medium itself usually becomes the message at the same time, much like how the form becomes the content.

Subjecting the viewer to reflection on events as mundane as driving a car or casting light on one's face may evoke a sense of inherently postmodern aimlessness. It is not difficult to see parallels between such endeavours and John Cage's creative attitude. Chołoniewski is a continuator of his idea of extending the range of musical sounds to include all kinds of non-instrumental and non-musical sounds and phenomena, as well as transferring art to different areas of reality. He finds the means to accomplish this in new media, confessing: 'I've always been interested in technology, and music was a learning endeavour. It was relatively late in my life that I realised what I was actually doing and what music was to me.'[952] Thus, many of Chołoniewski's projects on his path of artistic exploration took the form of experiments. Some concepts that have not been made reality make up the list of utopian projects, while others are developed in later implementations.

An important aspect of many of Chołoniewski's projects is the particular relationship between the auditory and visual layers. In *WYSYG*, *Lighting*, *Face*, and *Doubles*, he explores the possibilities of translating human gestures into musical gestures – both are, after all, part of the universal language of non-verbal human communication, conveying affective movement and emotion. After all, it is them where the intuitively-understood fusion of shape and energy takes place. He sees them as a necessary means of artistic performance, creating a thread of communication between the performer and the audience.

The cultural background of gestures, musical styles, and conventions is explored by Robert Hatten. Although he deals exclusively with tonal music, predominantly Classical and Romantic,[953] his musical

952 Chołoniewski, quoted in: Cyran, *Siedem odsłon Marka Chołoniewskiego*, http://www.polskamuza.eu/siedemodslon_archiwum.php?id=107.

953 See: Robert S. Hatten, *Musical Gesture*, http://www.chass.utoronto.ca/epc/srb/cyber/hatout.html.

gesture theory – with its core ideas and scientific basis – is universal enough to be applied to contemporary music. What exactly constitutes the artistic mechanism for translating human gestures into musical ones in Classical and Romantic music is dependent on the historical and geographical conventions of the style in question, the rules of instrumentation, harmony, and counterpoint, the composer's individual preferences, etc. In Chołoniewski's works, the entire process of transformation (or, one should say, 'transition', as in the piece *Passage*) from physical gestures to musical gestures is encapsulated in the functioning of inter-active computer systems. At the core of these systems lies an algorithmic software acting as a translator interpreting these two abstract languages. During such performances as *WYSYG* or *Lighting*, the viewer may observe how movement in real space corresponds with the sounds they hear, and how the shape and energy of gestures assume a musical form.

The logic of such music lies not only in the narrative, texture, or timbres, but also beyond, as it is governed by external data. Usually, these are algorithms that are a kind of metastructure of the auditory and visual message. In such projects, the weight of the creative endeavours is focused on developing effective control systems for individual pieces of computer software. The composer makes the tools he uses for creating and implementing new projects by himself. Thus, the it is not the works of art that become the artefact, but rather the tools for the creation of works of art. These tools are based on media rarely used in music, including the GPS, maps, motion and light sensors, and everyday objects.

Table 5.
A diagram illustrating the creation and 'live' processing of a multimedia composition

Surroundings	**Processing media**		**Results**
sounds movements light graphics	**microphones** light and motion **sensors** **GPS**	**original tools** for composition (ATTS, LTTS, MCOS, Max/MSP patches, *light baton,* Internet Loop, etc.) **effects processors** (delay lines) **sound equipment**	**sounds** (collages of quotations, bands of sound) **images** (graphics, score, computer animation)

The artistic stance of Chołoniewski is characterised by the need to constantly cross boundaries – media, aesthetic, and cultural alike. Using the universal language of new media, the artist combines high-brow art with low-brow art, the elite with the popular, and the local and indigenous with the global.[954] In the words of Grzegorz Dziamski, these are works:

> That are conscious of the fact that they are being produced in times of globalisation, but with no formal, stylistic, or content-related distinctions; to put it another way, it is not these distinctions that are the most important.[955]

In *GlobalMix*, *GPS-Trans*, and *Global Terrain* projects, one may clearly see the features of a contemporary art trend related to network media, namely Internet art. The technology employed for their execution enables the connection of activities by people who are far apart, while at the same time allowing immeasurable cyberspaces to be shared with other beholders. Global art is, on the one hand, in line with the idea of a 'world without borders' and Marshall McLuhan's theory of mass communication,[956] but, on the other, it also fits into the space of postmodern art. This is especially evident in works by Chołoniewski, characterised by a blurring of the boundary between elite art and mass art, as well as by intertextuality drawing a multifaceted grid of references for the viewer. Thus Chołoniewski wishes his art to be universal – transcultural on the one hand and transdisciplinary on the other, combining various fields of art.

In multimedia installations and performances, the audience becomes part of the work, of the whole vibrating space. Thus, it is important where and how such music is conveyed. In realising his projects, Chołoniewski departs from the traditional concert form, his installations and performances have no clear beginning or end, and the audience may enter and leave at any time. With his commentary, the creator introduces the arcana of the work to the audience just

954 Such tendencies had already appeared in electroacoustic music by Karlheinz Stockhausen, e.g. in *Telemusik* (1966) and *Hymnen* (1967), or by John Cage (*Musicircus*, 1969), which employed satellite links and a piece of computer software in order to create a global sonic space. Satellite television was also employed as a new artistic medium by Nam June Paik and Douglas Davis (*The Last Nine Minutes*, 1977, *Double Entendre*, 1981 – satellite and network links). Cf. Chapter 1.3.

955 See: Grzegorz Dziamski, *Kontekstualizm a sztuka globalna [Contextualism and Global Art]*, http://archiwum-obieg.u-jazdowski.pl/teksty/15794.

956 See: McLuhan, *Zrozumieć media…*

before (or even during) its performance, explaining the principles of the system and introducing the performers and their special roles in the performance of the work. He does not ask the audience to turn off their phones; on the contrary, he is open to all non-musical sound events. Indeed, Chołoniewski believes that the strength and potential of contemporary art lies precisely in open and direct forms of communication with the audience. In the mass society of our day, everyone wants to feel special, everyone has something to say, and everyone wants to express themselves in one way or another. If the passive contemplation of art is not enough for the beholder, and they want to participate in it, or even co-create it, Chołoniewski's works offer them the opportunity to do so.

The beholder's level of experience with new media is changing the way this type of art is received. A dilettante in the matter will view that what is taking place on stage very differently. Hence the open and accessible form of the projects, the break with the conventions of traditional serious music, and the emergence of art into the city space. Hence the lack of pretentiousness and pathos in the creator's attitude. The implementations of projects by Chołoniewski become spectacles of multimedia entertainment intended both for the competent viewer and the layman. The ironic, yet at the same time self-ironic play is intended to lead to the desacralisation of art.[957] The productions are meant to pique interest, surprise, engage, but also entertain – which is why the distance between the performers and the audience in productions by Chołoniewski is considerably reduced, with the boundary between the creator-initiator and the beholder-interactor-immersee even becoming blurred. In specific cases, the role of the composer in shaping the final form of the work is merely marginal. Thus, perhaps, one should perceive the deliberate 'death of the author' as understood by Roland Barthes here?

957 In such endeavours, one may perceive parallels with the work and aesthetic stance of Józef Robakowski.

3.6. Summary. The quest for a new sonority

The range of topics related to Polish electroacoustic music stretches very widely, as one may already see on the example of the five composers selected and discussed in part three. They reach for all the most important genres-currents of new media sound art: from 'tape' music – acousmatic – using concrete (Długosz, Knittel) or algorithmic techniques (Krupowicz), through live electronics (Długosz), human-electronics and improvisation with electrophones (Duchnowski, Knittel), to activities that transcend sonority, veering towards interactive performance and installation (Knittel, Chołoniewski), or even acoustic ecology (Knittel). They make use of traditional instruments, combining them with electronics and extending their possibilities (Długosz, Krupowicz) or transforming and deconstructing their sound (Duchnowski); in the line-ups, they include synthesizers and samplers, both in their hardware version (Knittel) and in the virtualised version available as part of computer software (Chołoniewski). Composers are also turning to media hitherto unseen in music, such as mobile phones or GPS devices (Chołoniewski).

When it comes to compositional techniques, sonoristic (Długosz), collagistic (Knittel) and algorithmics (Krupowicz, Duchnowski) techniques are employed, oftentimes subordinated to an overarching, conceptual idea (Krupowicz, Chołoniewski). Consequently, individual projects assume different forms, and are recorded and documented in different ways. Sometimes the notation is detailed (Długosz, Krupowicz), at other times it is generalised (Duchnowski), sometimes also graphic (Knittel) or expressed in words, containing only instructions for execution (Chołoniewski).

When it comes to sound shaping, composers make use of sound synthesis techniques (Krupowicz, Długosz), of various electrophones (Knittel), or deconstruct the sounds of acoustic instruments (Duchnowski). Speaking in broader terms, there is a tendency towards abandoning tape music in favour of combining different sound media, as well as expanding the composer's role to include directing and sound activities (Długosz), improvising (Duchnowski, Knittel), and performance (Knittel, Chołoniewski).

Compositional techniques and strategies associated with electroacoustic music may fulfil a variety of artistic purposes. Creative endeavours may be oriented towards creating an expanded sound (Długosz), ordering sound material (Krupowicz), transforming

acoustic instruments and constructing new, virtual ones (Duchnowski), or searching for a special, media-mediated kind of dialogue (Knittel) and interactive ludicity (Chołoniewski). All these aims have an impact on the meaning of the works, with composers seeking newer and stronger means of expression by expanding the possibilities of performers and instruments alike (Długosz), juxtaposing non-integrated qualities (Duchnowski, Knittel), or including the activities of beholders-interactors in the work (Chołoniewski). The praxis of electroacoustic music makes it possible to preserve traditional aesthetic values (Długosz), but also to transcend them (Krupowicz) or negate them (Duchnowski); it also allows one to adopt a postmodern stance (Chołoniewski) or even a countercultural one (Knittel). All of this is aimed at establishing a stronger contact – on an expressive, semantic, but also social level – with both the co-performer (e.g. in ensemble activities, where new media define the space for the musical encounter and interactive dialogue) and the audience, sometimes encouraged to take on the role of interactors or even co-creators.

Polish music associated with new media is clearly part of the 'performative turn',[958] which is manifest throughout the cultural sphere. Granted, the reception of music has always gone beyond the aural experience, especially in a concert setting, but never before have extra-musical elements been this important and employed by creators this extensively. This involves a move away from music for tape, 'closed' to interpretations, towards collective improvisation (Knittel, Duchnowski) or multimedia performance (Chołoniewski). Performisation also occurs in the sphere of interactive reception and participation,[959] requiring the intervention of the beholder-interactor (installations by Chołoniewski and Knittel).

As the famous phrase coined by McLuhan goes, *the medium is the message*. According to it, electroacoustic music is not only about sounds, but also about the synthesizer, the mixer and the loudspeakers, i.e. the technology and the way it is employed, with the latter becoming art itself[960] – a piece assembled from fragments of instru-

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958 See: *Zwrot performatywny w estetyce…*

959 Sylwia Szykowna, *Od kontemplacji do użytkowania [From Contemplation to Use]* [in:] *Komunikowanie (się) w mediach…*, pp. 284–297.

960 In his essay, *Friendly Alien: Object and Interface*, Lev Manovich draws attention to another important aspect of this phenomenon – the aestheticisation of devices, which, until recently, used to be assessed solely in terms of their functionality. Technological artefacts-accessories are no longer seen as a mere a conglomeration of cables and integrated circuits.

mental recordings is not a testament to the virtuosity of the performer, but rather to a skilful handling of the media. Electroacoustic works are therefore part of a new kind of art showing the 'beauty of technology'.[961] These new technologies are sometimes created along with the work, merging with it on the ontological level (Duchnowski's patchers, Chołoniewski's interactive systems). Without being able to proficiently use of electronics and computers, it is basically impossible to operate in the electroacoustic field. The excellence of the sound production of the project, such as the quality of the recordings, also becomes an aesthetic value in its own right. Technical perfection, however, is within the domain of popular culture, therefore, when it comes to art, a techno-aesthetic thus oriented becomes insufficient.

Electroacoustic art also harbours a certain conceptualism, which, according to Kluszczyński, is manifest in all varieties of media art.[962] As far as music is concerned, it is constituted over and above the division between absolute and programmatic music, while at the same time representing a move away from the dominance of 'technicality' towards the reflexivity of art. Indeed, the latter finds itself becoming the praxis of theory ever more often. One may relate this to algorithmic music (Krupowicz), performance (Chołoniewski) and acoustic ecology (Knittel) alike.

Włodzimierz Kotoński, the first Polish monographer in the field of electroacoustic art, points out that constitutes a response to the irresistible need of new generations of composers to renew their musical language.[963] The musical piece, not unlike the painting or sculpture, has become an insufficient form for contemporary artists – static, passive, and increasingly unreliable. Electronic media made it possible to radically expand the scope of music into areas hitherto inaccessible to it, and opened up new sonic horizons. For some, this represented a transfer of traditional values (beauty, expression) into a new sonic world (Długosz), while for others – who were in the majority – it represented an opportunity to break away from tradition, to escape from established values and patterns. In the context of the multitude of different types of phenomena, two types of attitudes and works emerge here: those going beyond sound, but still with a strong musical orientation, and those no longer pertaining to music *sensu stricto*, but

961 David Gelernter, *Mechaniczne piękno. Kryterium estetyczne w informatyce [Mechanical Beauty. The Aesthetic Criterion in Computer Science]*, translated by Alek Radomski (Warszawa: CiS, W.A.B., 1999).

962 Kluszczyński, *Sztuka interaktywna*…, p. 114.

963 Kotoński, *Muzyka elektroniczna*…, p. 16.

rather multimedia art – or new media art. With regard to the latter, there is a need for a new transdisciplinary field of research in the spirit of sound studies, combining the achievements of communication theory, media studies, social sciences, and even psychology and others.

Electroacoustic and multimedia works have become the domain of primarily young composers, for whom new media are an established, natural part of the musical world. This new generation of digital natives is already well aware of the possibilities and limitations associated with various technologies. There are few composers who would not have at least a few pieces using new media among their works. Music for tape, both concrete and acousmatic, is created in Poland by composers of the 'older' (Elżbieta Sikora, Ryszard Szeremeta) generation, but, above all, of the younger generation, too (Artur Zagajewski). Even more commonplace among them is the strategy of combining electronic media with acoustic instruments (in addition to the composers mentioned above, it is practised by people like Lidia Zielińska, Jacek Grudzień, and Katarzyna Taborowska). Within these currents, a particular interest in spatiality is exhibited by Michał Talma-Sutt and Ewa Trębacz, the latter living and working in the United States, exploring the possibilities of new omnidirectional and three-dimensional sound projection systems.

Owing to the organisational and pedagogical activities of Stanisław Krupowicz, a trend often embraced by a large group of composers from Wrocław is live electronics (Sławomir Kupczak, Marcin Bortnowski, Paweł Hendrich, Ryszard Osada, and Agata Zubel). In turn, elements of instrumental theatre combined with new media are used by the alumni of the Kraków Academy of Music, Karol Nepelski and Jakub Polaczyk. Audiovisual projects in the spirit of video art are created by Jarosław Kapuściński, Aleksandra Gryka, Jagoda Szmytka, and Łukasz Pieprzyk. Hybrid installation forms, as well as soundscape environments, are explored by Rafał Zapała.

It is difficult not to agree with Jack Szerszenowicz, who said that:

> The tendencies of going beyond the classic – homogeneous – media will most certainly intensify due to the emergence of new tools and ways of creation. Even if we recognise that this will not eliminate autonomous activities or lead to the complete unification of art.[964]

In support of this thesis, the author quotes the words of composer Marta Ptaszyńska:

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964 Szerszenowicz, *Inspiracje plastyczne w muzyce*…, p. 580.

> Music is moving towards globality, multimedia. (…) With the current global development of technology, all trends, currents, and styles are merging into some new organism with a global reach. (…) I'm under the impression that we will soon witness the birth of a new kind of musical language, incorporating various, sometimes perhaps completely unexpected elements.[965]

New media are radically influencing all aspects of electroacoustic works. After all, electronic devices accompany composers at every stage of the creation of a piece:

— at the conceptual and pre-compositional stage (collection of sound material, design of algorithms and software);
— in the composition and notation process (electrophones, sequencers, audio recording, note editors);
— in the performance process (control computer systems, sound systems);
— in the documentation process (of the works themselves, but also of the tools developed for them);
— in the dissemination process (audiovisual and web presentations).

The issue of sound art phenomena is, therefore, complex and multidimensional. The practice of music is always ahead of theory, in a certain sense entering its scope; it is often oriented towards experimentation, towards the creation of a new aesthetic situation, towards a constant redefinition of the terms 'work', 'artist', and 'music'. The effects are manifold, and at times controversial. They provoke reflection on the meaning and value of such art. There remain open questions. Does the fascination with the possibilities of new media not obscure or stifle the final artistic results? Is it not the medium that dominates and the message that becomes weakened? Instead, one might venture to say that true electroacoustic art begins when new media cease to be 'new' to the artist.

965 Ewa Cichoń, Leszek Polony, *Muzyka to język najdoskonalszy: rozmowy z Martą Ptaszyńską [Music is the Most Perfect of Languages: Conversations with Marta Ptaszyńska]* (Kraków: Polskie Wydawnictwo Muzyczne, 2001), p. 82, quoted in: Szerszenowicz, *Inspiracje plastyczne*…, p. 580.

Concluding remarks

The aim of the present work was to identify and explore the areas of the strongest influence of new media on music and, at the same time, to examine the most vibrant musical trend that has developed in recent decades – electroacoustic music. In part one, I tried to show how electronics has, in a short period of time, caused the development of a number of new instruments, genres and musical forms. My attempt to typify and define them showed how many of them straddle the lines between music and other arts, as the very use of multimedia prompts the artist to act transdisciplinarily. The second part aimed to highlight the significant impact of new media on the poetics and aesthetics of music. It is electroacoustics that provides the key to a world of new sonority, and enriches the sound arts with a 'new dimension', an equal formal element at the same time – spatiality. These two aspects – synthetic sonority and hybridisation of acoustic space – combined with the key features of new media – interactivity and virtuality – had a significant impact on the way a piece is perceived. This is because electroacoustic and multimedia works constitute an attempt to create a different, more powerful message, and this requires different perceptual skills and cognitive patterns. The first two parts of the present thesis provided an introductory overview of the fundamental issues, but were also intended to be helpful in developing adequate terms and descriptive language for use in part three. It includes interpretations of a selection of works and projects representative of the topic, synthetic summaries of the electroacoustic works of five selected composers, and a comparison between them. The work's proposed approach to the issue from several perspectives – historical, technical and aesthetic – may provide a starting point for further, more specialised research.

The endeavours undertaken within the field of contemporary music are constantly intersecting with science and technology. The inclusion of electronic means allows one to transcend all human limitations, but also the possibilities of the sound media (sonic, textural, spatial) available in the past; this also allows a break from the techniques and aesthetics of the past. After all, the technological approach of composers creating electroacoustic music towards sonority may sometimes be quite different from that encountered in the case of traditional composition. It may be focused not on the work, but on the

medium itself, such as on the creation of new instruments. New media also give one access to a path beyond sonority, becoming a bridge between music and multimedia art, engaging the audience's senses more strongly. In such settings, one might say that electroacoustics develops outside the framework of its original discipline, finding a place between genres and media.

The presence of new media in music forces one to redefine its basic concepts. Sometimes, terms as common and fundamental as 'piece', 'performance' or 'audience' become inadequate for the phenomena under study. Installation art, after all, defines a new status for the creator: they are neither a painter, a poet, nor a composer, but – simply put – an artist. As a result, it seems increasingly justified to replace the term 'electroacoustic music' with 'sound arts' (*Klangkunst*, *arte sonoro*, *l'art sonore*).[966] Moreover, given the transgressive nature of many an electroacoustic work, one could use the term t r a n s - a u d i a l m u s i c.

The particular involvement and activation of the beholder, including on a corporeal level, that interactive art entails is, in turn, part of a more general cultural trend that is also reflected in aesthetics. Among those heralding a return to broadly-understood sensuality are Arnold Berleant and Richard Shusterman. While the fine arts have, since the dawn of history, relied on the senses of sight and hearing (as tools for distance viewing), they are annexing new areas of perception through multi-media forms. Installation genres, such as sound sculpture, may target the sense of touch, and sometimes even smell. By widening the perceptual field, this kind of art aims to bring one immersive experiences, becoming a caress of the senses, and sometimes even a somatic stimulant.

For many traditionally-oriented composers, the adaptation of new sound media and new, sometimes radical, means of expression have not changed the essence of the music itself. Media art, especially in Poland, is a young, intensely-developing field. This may be the reason why the technological breakthrough has not yet overly disrupted the traditional functions of music. Roger F. Malina argues that 'we are very much in the 'dark' ages and not yet the 'middle ages' of the way that digital cultural is re-shaping knowledge'.[967] Gene Youngblood and Steve Holzmann also believe that new media have not reached

966 Just as 'painting' and 'sculpture' have given way to the 'visual arts'.

967 Roger F. Malina, *Na drodze do Trzeciej Kultury [Third Culture? From the Arts to the Sciences and Back Again]* [in:] *W stronę trzeciej kultury…*, p. 23.

an adequate stage of exploitation, as artists have not yet fully liberated themselves from the constraints of old paradigms, historical forms, and habits. According to Youngblood, the aesthetic potential of the media will only be fully realised:

> When computer artists come to the instrument from art rather than computer science. (…) [when] the kind of simulation envisioned (…) finally [becomes] accessible to autonomous individuals, the full aesthetic potential of computer simulation will be revealed.[968]

One may see new media as the pinnacle of cultural development – the awaited synthesis of art and science. Following in the techno-aesthetical lead, one should therefore conclude that contemporary art is still at the stage of fascination with new media. Meanwhile, according to many researchers, this situation seems to be changing. For the music of the early 21st century, the media have become something natural, everyday and obvious. Today, electroacoustic art is not an entirely separate genre (as almost from its very beginnings it has intermingled with instrumental, acoustic works), and, with the blurring of the boundary between the electro and the acoustic, a unique relationship between aesthetics and technology has been established. This is why researchers such as Peter Weibel believe that culture is already entering a post-media phase, i.e. one in which media art is not a separate category. After all, nothing happens in art and culture outside the boundaries of media space and the rules governing media forms. Following the digital revolution and all the experiments and experiences with new media, post-media art is expected to arrive, closing the period of admiration for the medium itself.[969] Artists like Kim Cascone[970] or Mel Alexenberg,[971] as a result of a certain disappointment with the achievements of science and technology are already

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968 Gene Youngblood, quoted in: Lister, Dovey, Giddings, Grant, Kelly, *New Media. A Critical Introduction…*, p. 96.

969 Certain elements of this attitude are already evident in music by spectralists. These composers, after all – despite aiding themselves with new media – wrote music that was mostly acoustic. As 'post-electronic' artists, they have access to the technological experience accumulated by the previous generation, and they are aware of the complexity of sonic phenomena. Nevertheless, they return to the nature of acoustic sound, composing for traditional instruments.

970 Kim Cascone, *The Aesthetics of Failure: 'Post-Digital' Tendencies in Contemporary Computer Music*, *Computer Music Journal*, 2000, Vol. 24, issue 4, pp. 12–18, http://www.mitpressjournals.org/doi/abs/10.1162/014892600559489?journalCode=comj.

971 Mel Alexenberg, *The Future of Art in a Postdigital Age. From Hellenistic to Hebraic Consciousness*, University of Chicago Press, Chicago 2006.

prophesying the arrival of the next post-digital era of 'embodied' media. The beginning of this era – the turn of the 20th century – is at the same time becoming the end of a revolution: according to Nicholas Negroponte's famous thesis, the digital revolution is over[972]. Digital and virtual content have ceased to be mere additions to human existence, and now constitute an integral part of the human universe. Ever more cultural artefacts that would seem to exist only in the real world are becoming digitised. One day, non-virtual sound concretisations may become relics of the past. After all, the resources of the virtual world are infinite; as Piotr Gawrysiak reminds us, the bits from which digital copies are constructed are not subject to wear and tear, and their stock cannot be depleted.[973]
Piotr Celiński writes:

> There are currently no media technologies that dominate the practice of art, or that are excluded from it by definition. Phase two involves the collapse of all these media forms into one another. The melding media lose their uniqueness, and, further, identity in general.[974]

Andrzej Gwóźdź adds:

> …the media mediatise one another, influencing and complementing one another, creating new, previously unknown configurations.

The post-media condition thus construed involves equating the cultural status of all existing media and arriving at a moment when all tools of artistic expression are treated equally. After all, what are the two worlds of traditional, 'acoustic' music, and transaudible, electroacoustic art, if not two parts of the same universe – the art of sounds?

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972 Nicholas Negroponte, *Beyond Digital* (1998), http://web.media.mit.edu/~nicholas/Wired/ WIRED6–12.html.

973 Piotr Gawrysiak, *Cyfrowa rewolucja.* p. 22.

974 Piotr Celiński, *Postmedia. Cyfrowy kod i bazy danych [Postmedia. Digital Code and Databases]* (Lublin: UMCS, 2013), http://www.postmedia.umcs.lublin.pl/celinski/a041/.

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ANDRZEJ MĄDRO

PhD, is a music theorist and Assistant Professor at the Krzysztof Penderecki Academy of Music in Krakow. His scientific interests include the music of recent decades, especially that which finds its place on the genre and aesthetic borders of art: progressive (from rock to djent), electroacoustic, and Polish jazz. His current research focuses on polymetry and tempo modulation. He is also a co-organizer of scientific symposia, including Metal Music Studies (Krakow, since 2020), the international conferences of the Progect Network for the Study of Progressive Rock (since 2022), Blues-Rock. Media–Scenes–Resonances (Torun, 2023), and Popular Music Cultures (Krakow, 2025). In his teaching practice, he explores the possibilities of applying new technological solutions such as interactive systems, computer software, and network-based communication. In 2019, he received The Decoration of Honor Meritorious for Polish Culture; in 2024, the badge Honoris Gratia awarded by the Mayor of Krakow.

The present book is a translation of the monograph *Muzyka a nowe media. Polska twórczość elektroakustyczna przełomu XX i XXI wieku*, for which the author received the First Prize in the Doctoral Dissertation Competition on Polish Music organized by the National Institute of Music and Dance (2021), the Father Professor Hieronim Feicht Award granted by the Musicologists' Section of the Polish Composers' Union (2017), as well as the Recommendation and Audience Award for the best music book published in 2017 in the "KROPKA" Polish Music Critics' Competition (MEAKULTURA Foundation, 2018).

The book examines the historical evolution of sound media – from the human voice and acoustic instruments to print, phonography, radio, digital recording, computers, and the Internet – and shows how these technological shifts transformed musical creation, performance, and listening. The author presents key characteristics of new media such as multimediality, interactivity, virtuality, digital sound processing, spatialization, and immersive environments, arguing that these factors fundamentally changed artistic practices. The book also highlights the need for interdisciplinary analytical tools combining musicology with media studies, acoustics, communication theory, and aesthetics.

A significant part of the study is devoted to Polish electroacoustic composers, including Stanisław Krupowicz, Magdalena Długosz, Cezary Duchnowski, Krzysztof Knittel, and Marek Chołoniewski. Their works illustrate diverse approaches: algorithmic composition, live electronics, interactive systems, acousmatic music, multimedia installations, and sound art. Overall, the book positions electroacoustic creativity as a central field within contemporary art, showing how new media redefine musical language, artistic strategies, and modes of perception, ultimately shaping a new, technologically grounded musical culture.