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Problematising the analysis of electronic music – a survey of proposals

The subject of analysis

Electronic music has not been unambiguously – and therefore permanently – categorised. As a result, many researchers in this area adopt the terms *electronic* music or *electroacoustic* music.[1] What then is the music that these terms refer to? Is it just a question of the adopted translation? After all, in the global literature, we also have, for example, the German version *elektronische Musik*,[2] as well as the French *musiques électro-acoustiques*.[3] On one hand, however, the content of studies containing these terms demonstrates that the central problems of interest for their authors are essentially the same: the new creative possibilities emerging

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[1] Cf. *The Cambridge Companion to Electronic Music*, ed. N. Collins and J. d'Escriván (Cambridge, 2017); C. Roads, *Composing Electronic Music: A New Aesthetic* (New York, 2015); S. Emmerson (ed.), *The Language of Electroacoustic Music* (London, 1986); T. Licata (ed.), *Electroacoustic Music: Analytical Perspectives* (Westport, 2002).

[2] Cf. W. Meyer-Eppler, *Elektrische Klangerzeugung, elektronische Musik und synthethische Sprache* (Bonn, 1949); W. Kaegi, *Was ist elektronische Musik* (Zurich, 1967).

[3] Cf. F. Delalande, 'L'analyse des musiques électro-acoustiques', *Musique en jeu*, 1972/8, 50–56; M. Chion and G. Reibel, *Les musiques électroacoustiques* (Aix-en-Provence, 1976).

since the 1940s as a result of the electronic processing of sounds or their synthetic production. On the other hand, the range of periods in which the many scientific and popular science publications have appeared allows us to put forward the hypothesis that their authors had in mind different stages in the development of this music and, in consequence, their different kinds. In support of this thesis, it is worth remembering that during the 40s Werner Meyer-Eppler worked primarily on synthetic speech (*synthethische Sprache*) and, using combinations of simple tones (additive synthesis) obtained from a generator, created sound models unknown at that time (*Klangmodelle*), which in turn served the later composing of electronic music (*elektronische Musik*). Włodzimierz Kotoński emphasised that:

> the work *Elektryczne wytwarzanie dźwięków* [The electrical production of sounds] […] was a signal for broader interest in this area to be taken by composers with a more avant-garde attitude. […] The first compositions were […] the four etudes written jointly by Herbert Eimert and Robert Beyer: *Klang in unbegrenztem Raum* (1951/52), *Klangestudie I* (1952), *Klangestudie II* (1952/53) and *Ostinate Figuren und Rhythmen* (1953). […] Synthetic sounds from that period were simple and poor but totally different from the familiar instrumental sounds, and that was what fascinated listeners.[4]

The strong orientation of the activities of the German community of sound engineers and composers towards creating music out of synthetic sounds meant that in the German-language scientific literature the term *elektronische Musik* became permanently established, and this is translated into Polish as *elektroniczna muzyka* [electronic music]. The process itself of creating the material of this music related to synthesising new sounds, and thus required, for example, generators of sinusoidal signals or noise, tape recorders, a circular modulator and a new electronic instrument used at the Studio for Electronic Music in Cologne, namely, Harald Bode's melochord.

The situation is different in the case of music where at least one of the sound sources is an electronic instrument, such as a music synthesiser, or played-back recordings of sounds from a magnetic tape. Very often, particularly during the 1950s and 1960s, these sound sources were configured with the sounds of conventional instruments and/or human voices; e.g. two compositions by Tomasz Sikorski from 1963, *Echa II* [Echoes II] for 2, 3 or 4 pianos, percussion and tape, and *Antyfony* [Antiphons] for soprano, piano, horn, bells, 4 gongs and tape. The participation of so-called conventional instruments and electronic instruments in shaping the musical narration of such compositions provides a quite convincing explanation for the name *muzyka elektroakustyczna* [electroacoustic

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4 W. Kotoński, *Muzyka elektroniczna* [Electronic music] (Kraków, 2002), 25, 27.

music] given to music composed in this way. However, we should also bear in mind the aspect drawn to our attention by Kotoński:

> All these productions, regardless of the ways the sounds were obtained or the attitudes and intentions of the composers, have one feature in common, namely, that the final effect is achieved through the use of electroacoustic equipment. The 'instrument' that produces the audible sound is the speaker stimulated to vibrate by electrical signals.[5]

Sounds emitted by the quivering membranes of speakers are in essence mechanical acoustic waves, as are the sounds intoned by conventional musical instruments. But electronic instruments require the sounds they generate to be led onto an electroacoustic track, where the electromagnetic wave is transformed into a mechanical wave, and vice versa. In view of this, it seems quite justified to call this *electroacoustic music*.

Other examples of music are discussed in *The Cambridge Companion to Electronic Music*, edited by Nick Collins and Julio d'Escriván. The chapters of this monograph include Karlheinz Essel's on 'Algorithmic Composition' (pp. 104–122) and Julian Rohrhuber's on 'Network Music' (138–153). It is thus not surprising that Collins and d'Escriván refer to the music described as *electronic music*.

The music that is the subject of the present reflection, in the context of the 'notional and ideological entanglements of music analysis',[6] belongs to a very wide and diverse trend in compositions of the last two centuries. The year 2018 saw the publication of a multi-authorial monograph edited by Simon Emmerson and Leigh Landy titled *Expanding the Horizon of Electroacoustic Music Analysis*.[7] In the first chapter of that monograph, Emmerson and Landy – referring to the Electro Acoustic Resource Site (EARS)[8] – draw attention to a fact of great significance for our deliberations: namely, the existence of a list of 81 genres and categories of electroacoustic music, distinguished through the use of different

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[5] Ibidem, 13.

[6] This text is an expanded presentation of issues first highlighted during the III Ogólnopolska Konferencja *Metody analizy muzyki XX i XXI wieku*: *Ideowe i ideologiczne uwikłania analizy muzycznej* [3rd national conference on methods of analysing music of the twentieth and twenty--first centuries: the notional and ideological entanglements of music analysis], Gdańsk, 26–27 November 2021.

[7] S. Emmerson and L. Landy (eds), *Expanding the Horizon of Electroacoustic Music Analysis* (Cambridge, 2018).

[8] See http://ears.dmu.ac.uk/.

criteria that led to certain conventions in terminology, although – and the authors emphasise this – in no way are they mutually exclusive.[9] A word used to describe a given category 'may migrate in meaning to describe a genre' (e.g. acousmatic). The authors' comment provides sufficient justification for placing the term *electroacoustic music* in the title of the monograph, although it should be noted that this title also suggests the need to expand the analytical horizon in relation to this music. In a way, this confirms the observation made by Kotoński, who, adopting the name *muzyka elektroniczna* for the music discussed here, explicitly expresses the view that:

> Today there is virtually no area of music where there is no electronic processing of sounds or use of synthetically produced sounds. Electronic music has penetrated concert and radio programmes, theatre and opera; it accompanies films and TV programmes; it has come to dominate some sections of entertainment. Although it has not driven out instrumental music […] in some areas it has become simply irreplaceable. […] Electronic music, regardless of its kind, is aimed at the production, or creation, of music that does not exist at all outside the electroacoustic sphere.[10]

In view of these merely signalled reasons for the dual naming of the music discussed here – *electroacoustic* versus *electronic* – the present reflection takes into consideration Włodzimierz Kotoński's proposal, especially since such individual genres as *progressive house*, *electro house*, *ambient*, *techno* and *glitch*, on account of their sound source (music synthesiser, keyboard, sampler, gramophone, vocoder or percussion machine), are associated more with electronics than with electroacoustic transformation.

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[9] 'The Electro Acoustic Resource Site […] lists 81 genres and categories of electroacoustic music – these are effectively naming conventions, clustering into two categorisations which are in no way exclusive: a *genre* is a musical or artistic grouping (e.g. *soundscape* or *acousmatic*), whereas a *category* is grouped around a *performance situation*, an *aspect of technology* or an *approach* (e.g. *installation*, *microsound*, *algorithmic*). But sometimes the distinction of genres and categories cannot easily be maintained. A word used to describe a category may migrate in meaning to describe a genre – some might argue this is true of 'acousmatic'!". Cf. S. Emmerson and L. Landy, 'The analysis of electroacoustic music: the differing needs of its genres and categories', in *Expanding the Horizon of Electroacoustic Music Analysis*, 8.

[10] Kotoński, *Muzyka elektroniczna*, 13, 14.

Understanding the ideas

It was noted earlier that our reflections here will focus on the 'notional and ide-ological entanglements of music analysis'. However, the realisation of specific *ideas* concerns not only music analysis, but also the creation of electronic music itself. Yet the question arises as to how one should understand the *idea* in relation to music analysis or to the composing of electronic music. This is one of the main concepts that has had different definitions in particular philosophical systems. That is why, for the purposes of this discussion, on pragmatic grounds, we have adopted a specific dictionary definition of an idea as 'a keynote that determines the aim and direction of activity, being also a fundamental tendency in scientific and artistic output'.[11] In the context of this adopted definition, it is worth emphas-ising that both the creators of electronic music as broadly understood and its researchers – seeking to get to know and understand it – choose a specific aim or aims and direction or directions for their work.

From today's perspective, it seems clear that, in relation to the beginnings of electronic music, the idea, that is, the designated aim – for Pierre Schaeffer, for example[12] – became to compose music using sounds that previously had been regarded as 'non-musical noises'. Recorded natural sounds, such as the sounds of rumbling trains, the turning of a drum music box, birdsong or factory noises, 'musicalised' by composers giving them a discernible rhythm, repeating or con-trasting them or configuring them in counterpointing layers, became the sound material, the further montage of which led to the creation of new timbral qualities and, finally, to new music. Creating such music as if back-to-front, that is, from specific material, through numerous attempts to modify and configure it (experi-mentation), to obtaining an essentially abstract product, that is, a musical work, was precisely Schaeffer's course of action – his *idea*, that is, the fundamental tendency of his artistic work. He was guided by the notion of creating new music – concrete music (*musique concrète*) which, in contrast to the music that preceded it (usually born from an abstract idea, or concept, expressed in a recor-ded form (a score) and concretised in performance), was in its way a response

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[11] 'Idea', in *Słownik języka polskiego PWN* [PWN Polish dictionary], ed. M. Szymczak (Warsaw, 1978), i:765.

[12] It is worth remembering that the composer was a sound engineer at the Paris RTF (Radiodif-fusion-Télévision Française), where he worked on the montage of the sound layer that accom-panied film images and radio dramas.

to Ferruccio Busoni's postulated idea about music – that is was 'born free; and to win freedom is its destiny'.[13]

A later example of electronic music is *ambient* music. Its creation was accompanied by a completely different idea. The keynote behind the specific tendency in the artistic activity of Brian Eno was – in the words of Sylwia Makomaska – the creation of the concept of

> ambient music, which the composer presented and developed during the 1970s and 1980s. This original proposal to fill various types of spaces (including public spaces) with artistic music (as a background) […]. To define the new type of electronic music, Eno chose an ambiguous term perfectly suited to discussion of so-called 'environment music'.[14]

Makomaska, explaining Eno's idea, points out that 'Technological changes (in particular the appearance of audio tape) provided an opportunity to construct new soundworlds, and it also'[15] – quoting Eno:

> gave rise to the particular area that I'm involved in: in-studio composition, where you no longer come to the studio with a conception of the finished piece. Instead, you come with actually rather a bare skeleton of the piece, or perhaps with nothing at all. […] It puts the composer in the identical position of the painter – he's working directly with a material, working directly onto a substance, and he always retains the options to chop and change, to paint a bit out, add a piece, etc.[16]

These two examples of electronic music – concrete music and ambient music – already demonstrate how different are the ideas of composers of electronic music – the keynotes that determine the aim and direction of their work. Obviously, the above examples do not exhaust the abundance of ideas or basic tendencies in the creation of electronic music as broadly understood. The rich variety of creative ideas leads to a multiplicity of genres of electronic music. So it is not surprising that researching electronic music is inevitably linked to many tendencies in scientific study.

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[13] F. Busoni, 'Sketch of a New Esthetic of Music', in *Three Classics in The Aesthetic of Music*, tr. Dr Th. Baker (New York, 1962), 77.

[14] S. Makomaska, *Muzyka na peryferiach uwagi. Od 'musique d'ameublement' do 'audiomarketingu'* [Music on the periphery of awareness: from *musique d'ameublement* to *audiomarketing*] (Warsaw, 2021), 156.

[15] Ibidem, 170.

[16] Ibidem, after B. Eno, 'The studio as a compositional tool', *Downbeat*, July 1983.

Reflection focused on the conceptual entanglements of music analysis thus requires an attempt to identify the ideas that determined the aims and directions of the work of researchers dealing with electronic music. Research is supposed to lead to a better understanding of certain aspects of a given work of electronic music, although the research itself does not necessarily presume the concrete application of its results. Thus in this case the idea of scientific work would be researching electronic music in order to learn about and understand the idiomatic aspects of its specific genre or – where genre markers intertwine – generic hybrid. This kind of research which leads, for example, to establishing analytical perspectives commensurate with studying specific aspects of genres of electronic music is exemplified by a multi-authorial monograph under the editorship of Thomas Licata,[17] where the scholars apply their methods to the 'classics' of electronic music, such as *Gesang der Jünglinge* (1955–1956) and *Telemusik* (1966) by Karlheinz Stockhausen, *Diamorphoses* (1957) by Iannis Xenakis, *Essay* (1957–1958) by Gottfried Michael Koenig, *Omaggio a Emilio Vedova* (1960) by Luigi Nono, *Contours* (1982) by Jean-Claude Risset and *A Study in White* (1987) by Joji Yuasa. For example, research into *Gesang der Jünglinge* focuses on analysis of the sound material – the pre-recorded boy's voice and the synthesised sounds – on the basis of Stockhausen's drafts. The sound material configured in this work was subjected to numerous extended serial procedures used throughout the composition, and investigating and understanding them as a result of analysing the source material is the idea behind research conducted in this way. On the other hand, analysis of *Diamorphoses* was conducted on the basis of sonograms of the recorded sound material, which comes from bells, the roar of aeroplanes and explosions. Analysis of the data obtained from sonograms makes it possible to realise the research idea, which is to gain insight into the general development and final synthesis of these contrasting sounds, thus revealing the dynamic formal project of the work. Analysis of *Essay* adopts a different approach, of particular interest in which seems to be the fact that it concerns not the product of the composition process itself (the musical composition), but the technical and compositional procedures which ultimately lead to its creation. Works composed during the 1980s exemplify the use of computers, which help composers to realise the musical soundscapes they create. A work created in this way, such as *Contours*, produced totally from computer sound synthesis, requires yet another research idea. The score of Risset's work is the set of all the text files created by the composer for computer representation both of the algorithms of the sound synthesis and the

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[17] Licata (ed.), *Electroacoustic Music: Analytical Perspectives*.

list of sound events. Each text file contains a sequence of computer instructions which follows a specific method of sound synthesis, as well as the parameters of the list of notes, usually in chronological order. Analysis of music created in such an unconventional manner concerns detailed study of the 'instruments' and score designs created by Risset for this work, as well as his drafts and annotations. The subject of analysis are the sound structures obtained as a result of using different synthesis techniques, as well as their integration into the general form of the work.

These examples clearly show that the ideas behind research work are linked to compositional strategies that determine the specific aspects of a given genre of electronic music. Discovering and understanding them defines the aim and direction of the research being conducted.

Analysis carried out by composers themselves in relation to their practical work is guided by a different idea. Emmerson and Landy suggest that composers' analysis of their own works (or those of others) before they start composing a new work is intended to lead to an understanding of specific aspects of their own (or others') work that might influence the newly created composition.[18] Activities directed in this way often lead to the identification of features of one's own work that were not a conscious part of the composition process. This suggestion by Emmerson and Landy is confirmed by the words of one of the leading composers whose works include electronic music, Luciano Berio:

> Analysis is not just a form of speculative pleasure or a theoretical instrument for the conceptualization of music; when it contributes to the transformation of sound forms […] it can make a profound and concrete contribution to creative process.[19]

An analytical approach to electronic music during its performance allows one to consciously follow the potential of the musical material being performed and make decisions about its pre-determined use in a current performance (or later performances), or about the need to modify it during that performance. Emmerson and Landy also point out that one interesting tendency in research work is didactic analytical activity aimed at supporting the understanding of a work in general and also – based on the results of its analysis – illustrating,

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[18] Emmerson and Landy, 'The analysis of electroacoustic music', 12.

[19] L. Berio, *Remembering the Future* (Cambridge MA, 2006), quoted after: Roads, *Composing Electronic Music*, 119.

or exemplifying, the general ideas and concepts contained in the electronic music being studied.[20]

This leads to the conclusion that the notional entanglements of the analysis of various genres of electronic music result from the different directions to activities ensuing from different research aims, as well as the multiplicity of genres and categories of electronic music per se – being the effect of adopting fundamentally varied tendencies in artistic work (compositional ideas) – or the diversity of the attitudes and expectations of research users (scientific ideas).

Understanding the analysis of electronic music

The title of this section might suggest the existence of some established attitudes towards the analysis of electronic music. However, the main theme of this reflection, formulated as 'problematising the analysis of electronic music', allows us to suppose that in such a discussion we will encounter more difficulties, complications and vagueness than clear principles and established regularities. In interpreting the 'notional entanglements of music analysis', one should remember that those 'entanglements' relate to the idea which determines the aim/s and direction/s of the activities of music analysts. What then might those aims and directions be? What ideas determine them? In trying to answer these questions, it is useful to remember the well-known definition of analysis put forward by Ian Bent, who claims that analysis is:

> The resolution of a musical structure into relatively simpler constituent elements, and the investigation of the functions of those elements within that structure. […] all the comparative processes that characterize stylistic analysis are inherent in the basic analytical activity of resolving structure into elements. A more general definition of the term […] might be: that part of the study of music which takes as its starting-point the music itself, rather than external factors.[21]

In the context of such a general definition of analysis, doubts arise as to the analytical activities indicated here when analysis is to be applied to electronic music in particular. Emmerson and Landy correctly observe that, in relation to electronic music as broadly understood, a problem arises in relation to convin-

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[20] Emmerson and Landy, 'The analysis of electroacoustic music', 12.
[21] Cf. I. Bent, 'Analysis', in *The New Grove Dictionary of Music and Musicians*, ed. S. Sadie and J. Tyrrell (London, 2001), i:340–341.

cingly identifying the idiomatic and unique structures of electronic music which would be resolved 'into relatively simpler constituent elements'. That is because the synthetic sound material of that music is in itself created 'bottom up', without the sort of initially formulated structure that characterises many forms of non- -electronic music, which means that the music created in this way is, so to speak, a *bottom-up composition*. Moreover, analysis does not need to encompass the whole work, but can focus on just one or a few aspects of a composition. Structure does not have to be one of them, unless it is relevant to an understanding of the analytical aims or intentions.[22]

The fundamental difficulty in analysing electronic music according to the general understanding of analysis given above is aptly expressed by Curtis Roads:

> Music analysis is a problematic endeavor. The task of analysis based on a printed score is fairly straightforward, though it is hardly a science. The starting point – a score – is already a simplified high-level symbolic representation of a more complex phenomenon: a pattern of air vibrations. In contrast, when analyzing electronic music, a main goal is precisely to try to find a score (a repertoire of symbols) in the waveforms. In practice, this is difficult, as there are often no standardized, homogeneous units like notes in electronic music (Bossis 2006). Many analytical accounts of electronic music tend toward the anecdotal or philosophical (Griffiths 1979; Smalley 1993; […] Heikinheimo 1972; Roads 2005; Roy 2003; Hinkle-Turner 2006 […]). The central narrative in electronic music often revolves around timbral elements projected in virtual spaces. Thus the development of a proto-science of electronic music analysis depends on the ability to describe both timbres and spaces, their combinations, and their time-varying mutations. Yet the development of a vocabulary of descriptors for timbre is in its infancy, and the practice of virtual spatialization is far ahead of any descriptive aesthetic theory.[23]

Another important feature specific to electronic music is the use of analysis to construct sound material that is acceptable to the composer. This seems to be a very peculiar use of analysis – not so much *ex post*, that is, to identify creative means and techniques present in an already composed work, as *ex nunc*, before the synthetically produced sound material is selected and configured, in order to ensure that it conforms to the composer's imagined musical narrative. This is the 'case' of analysis carried out not by a researcher but by the composer; moreover, it often results in a decision to transform the sound material obtained to make it

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[22] Emmerson and Landy, 'The analysis of electroacoustic music', 10.

[23] Roads, *Composing Electronic Music*, xxi.

fit the model adopted during the creative process. According to Roads, analysis that precedes the creation of electronic music may proceed in two different ways:

> In simple forms of analysis, one can perform the analysis and transformation in real time. In other cases, the analysis and transformation are performed as two separate steps. Every method of analysis should be viewed as fitting the input signal to an assumed model. For example, spectrum estimation methods based on Fourier analysis model an input sound as a sum of harmonically related sinusoids – which it may or may not be. Other techniques model an input signal as a collection of atoms in a dictionary, a sum of square waves, a combination of inharmonically related sinusoids, a set of formant peaks with added noise, or a set of equations that represent the mechanical vibration of a traditional instrument. Variations in performance among the different methods can often be attributed to how well the assumed model matches the signal being analyzed. No method of sound analysis is ideal for all applications. Hence it is important to choose the appropriate analysis method for a given sound transformation.
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> One of the ways to test an analysis method is to resynthesize the sound based on the analyzed data. Some analysis methods […] must be carefully tuned to the characteristics of the analyzed sound […] in order to produce a convincing resynthesis [...]. The result of any analysis method is a representation of a sound based on the analysis model. Certain representations are more malleable than others with respect to transformation.[24]

At the present stage in the development of analytical methods, the analysis of electronic music, like the analysis of non-electronic music, has no general or comprehensive method: everything can be analysed in a variety of ways. Moreover, there are no limits to the number of aims linked to analysts' intentions when they take on research into electronic music. The method of analysis is chosen in order to realise one or many mutually linked aims. On the other hand, analysts' research intentions manifest their desire to cognise and understand many aspects of electronic music. Emmerson and Landy point out that analysts' intentions may concern the desire to reveal such aspects as structuring layers, narrative discourse, quality of sounds and their evolution in time, and gestures on a local level. Analyses may focus on studying the transition from one kind of listening to another (e.g. between context and music), drawing on social, emotional or semantic elements, and each kind of listening may be studied in combination with other aspects of electronic music: acoustic aspects and those related to performance. Bearing in mind the broad understanding of electronic music, with its numerous

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24 Ibidem, 119–121.

genres and categories, the researcher's intention may also concern the need to reveal the dramaturgical intention of the composer and/or aspects of composition.[25] One feature of the developing interest in the possibilities of analysing electronic music is the integration of its research community; thanks to this integration, researchers conducting specialised analyses can share their findings. This higher-level aim is served by, for example, the Online Repository for Electroacoustic Music Analysis (OREMA, http://orema.dmu.ac.uk/?q=analytical_toolbox). Many analytical proposals originate with Pierre Schaeffer's 'typomorphology' or Denis Smalley's 'spectromorphology', or their development proposed by Lasse Thorensen or Stéphane Roy.[26] Another significant analytical proposal is Simon Emmerson's idea of a 'linguistic network'.[27] In order to broaden the range of tools for analysing electronic music, between 2010 and 2013 the Arts and Humanities Research Council conducted a project called *New Multimedia Tools for Electroacoustic Music Analysis.* Its aim, while developing the resources of OREMA, was to develop EAnalysis – a multimedia software package that would move the visualisation of sound into new areas, enabling advanced annotation of its features not only for analysis, but also for wider application.

A survey of collective monographs that present analyses of selected examples of electronic music and the subject matter of articles in specialist periodicals indicate that, depending on the aims and directions of the research, analysis is applied to source materials that are essentially different and give us insight into the electronic music being studied. Their specific features determine the nature of various research methods. When researching sound material (different kinds of sounds used) and its morphology, as well as the changes observed within it, one takes into consideration both auditive analysis – during which one interprets the sound material itself and also its behaviour and function in the sound structures, which in turn require separate analysis in order to be precisely identified – and automated analysis, which allows the result of the analysis to be presented in visual form (representation).[28] It is also worth drawing attention

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[25] Emmerson and Landy, 'The analysis of electroacoustic music', 13.

[26] P. Schaeffer, *Traité des objets musicaux: essai interdisciplines* (Paris, 1966); Denis Smalley, 'Spectomorphology: Explaining sound shapes', *Organised Sound*, 2/2 (1997), 107–126; D. Smalley, 'Space-form and the acousmatic image', *Organised Sound*, 12/1 (2007), 35–58; L. Thorensen, 'Spectromorphological analysis of sound-objects: An adaptation of Pierre Schaeffer's typomorphology', *Organised Sound*, 12/2 (2007), 129–141; S. Roy, *L'Analyse de la musique électroacoustique: modèles et propositions* (Paris, 2003).

[27] Emmerson, *The Language of Electroacoustic Music*.

[28] In Polish musicological research, automated analysis has been used by Justyna Humięcka-Jakubowska and Iwona Lindstedt. See e.g. J. Humiecka-Jakubowska, *Intuicja czy scjentyzm:*

to the fact that the representation itself may take different forms. These may be sonograms, amplitude-temporal characteristics or more complex representations which allow for transcription and annotation (e.g. EAnalysis). Another problem is what might be described as the 'substance' of electronic music. We are still lacking a complete and universal system for categorising sound material. For this reason, some of its descriptions are based on the acoustic features of a known or inferred source (if we do not have any commentaries by the composer explaining this aspect of the work) or else use data generated by the spectral parameters of the sound material or other features revealed during automated analysis.[29]

The abundance of genres and categories of electronic music, as well as the mutual interpenetration of their specific features, means that the list of aspects taken into account in its analysis continues to multiply. Studying the sequence of sound events and their organisation in space, as well as the performative elements of multimedia genres, one takes into account both the composer's intention and the perceptual effect that evokes a specific social, emotional or semantic response, and this in turn requires the interpretation of the obtained results of analysis in the given context.

One research possibility that has appeared in this respect is analysing electronic music taking into account what is known as the theory of a work's density, proposed by Stephen Davies. Davies advances a typology of works, distinguishing among them *works for performance*, *works for playback* and *works for studio performance*.[30] The typology of works suggested here might be applied to attempts to categorise the various genres of electronic music. On the other hand, the idea of different degrees of density might be useful in differentiating those aspects of a work that should be taken into consideration in analyses. According to Davies, a lower degree of density characterises works that have few determining properties, and the majority of the performance features of such music are linked to the interpretation by the performer, and not to the work itself. According to this way of thinking, electronic music previously recorded on some medium and needing only to be played back during the act of performance has the highest

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Stockhausen – Ligeti – Nono – Berio – Xenakis – Grisey [Intuition or scientism: Stockhausen, Ligeti, Nono, Berio, Xenakis and Grisey] (Poznań, 2013); I. Lindstedt, *Sonorystyka w twórczości kompozytorów polskich XX wieku* [Sonorism in works by Polish composers of the twentieth century] (Warsaw, 2010).

[29] Cf. M. Simoni (ed.), *Analytical Methods of Electroacoustic Music* (New York, 2006).

[30] S. Davies, *Musical Works and Performances: A Philosophical Exploration* (Oxford, 2001), 14.

degree of density, and thus its analysis might focus on the recorded sound material and its organisation in time.

A more technologically advanced research proposal is to conduct analyses of multimodal signals (audio, video, images, human motion and biosignals). Analyses of this kind are being conducted, for example, by ImCognita Lab – a laboratory formed within the Interdisciplinary Nucleus for Sound Studies (NICS) at the Brazilian University in Campinas (UNICAMP). The team at ImCognita Lab:

> [...] develops a research program based on the creation of artwork combining multimodalities using interactive media, to produce digital immersion and augmented cognition, and to study human cognition and creativity using sensory devices, computer graphics, motion caption and bio-signals. [...] The ImCognita Lab aims to create a unified experience where data and user are merged in space (i.e. a true mixed reality experience) and evolve coherently in time (i.e. narrative progression).[31]

Problematising the analysis of electronic music in the broad sense, it is also worth noting the attempts at interactive analysis, where the analyst creates simulations aimed at revealing how the composer created the material, while the user may relive the evoked experiences, as well as trying out alternative solutions using the same technique.[32]

Challenges for the analysis of electronic music

There is no question that the relatively 'young' field of electronic music – with more than a hundred years' history – is increasingly of interest to researchers. It seems, however, that although many detailed analyses have been carried out, there are still too few fundamental works. The multimedia nature and multimodality of this music creates a challenge for researchers, since we do not have a wide selection of tools and methods for this type of analysis. In the works quoted here, we find the suggestion that much research is based on *poiesis*, that is, the construction of the work, and does not refer to its reception. That may be simpler

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[31] *The Routledge Research Companion to Electronic Music. Reaching out with Technology*, ed. S. Emmerson (London, 2018), 29.

[32] M. Clarke, 'Jonathan Harvey's *Mortuos Plango, Vivos Voco*', in M. Simoni (ed.), *Analytical Methods of Electroacoustic Music* (London, 2006), 111–143; M. Clarke, 'Wind chimes: An interactive aural analysis', in É. Gayou (ed.), *Denis Smalley: Polychrome Portraits* (Paris, 2010), 35–57.

analysis, since it is based on comments by the works' creators, as well as drawing data from available descriptions of technical means used in their creation.

One of the challenges for researchers exploring electronic music is to take into account both those aspects that can only be revealed by automated methods and those that may be identified auditively. Within the body of electronic works, there are still genres that have not been subjected to scientific study because of their multimedia character, for example, for which at present there are no appropriate tools or analytical methods.

The development of adequate analytical resources may be helped by verbalising what is expected of analyses of electronic music and identifying ways of meeting those expectations. Within the community of analysts of this music, there is a general belief that previous representations of research results impose certain limitations on the kind of analytical questions that can be asked of electronic music. It is thus also a challenge to find the best ways of representing the data needed for analysis from the point of view of a particular genre or category of electronic music. Finally, there should also be attempts to analyse genres that combine sound material generated conventionally with sound material from electroacoustically processed material or synthetic material. Each of them requires different analytical tools, and the analysis should lead to insights into the effects of configuring sound material so varied in its origin. Analysis should include subjects which have not been fully discussed to date. One such example might be research into the strategy of acoustic diffusion, achieved by means of an electronically arranged performance space, thus enhancing music created in a conventional manner with a spatial quality that helps to forge the musical narration (e.g. Luigi Nono's experiments with the halophone, which ensured that sound was dynamised in space, generating it with contrasting speeds through different speakers, or using natural reverberation or reflection).

The all-encompassing presence of electronic music mentioned by Kotoński testifies to its enormous potential, which undoubtedly deserves competent scientific study.

ABSTRACT

Electronic music is being subjected to musicological analysis increasingly often. However, neither the choice of tools and analytical methods nor the type of data included in the research ensures the acquisition of exhaustive knowledge about this music. The aim of this reflection is to draw attention to existing research trends in electronic music and to the causes of difficulties in selecting appropriate research strategies. In this context, an attempt is also made to identify the challenges faced by researchers analysing this music. The problematisation of the analysis of electronic music has been organised by distinguishing three core problems: the specific character of electronic music, taking into account its multimedia and multimodal nature and distinctive sound material; the idea behind analysis of this music; the achievements of researchers and the tasks faced by those undertaking the analysis of electronic music, taking into account the multiplicity of its genres and categories. These considerations are based both on the subject literature, already established in the field of musicology, and on selected recent monographs, as well as works published in specialist journals.

KEYWORDS: electronic music, analysis, tools, methods

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