Radio: An instrument in art – with reference to selected works by Polish artists

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This article explores the role of the radio as an artistic instrument. It discusses both contemporary and historical art experiments, namely those where the sound of the radio or the form of radio reception is an important aspect of the final work. We examine the question, 'What does it mean for a radio to be an instrument?' And to clarify, we mean any kind of instrument, not just a musical one. To answer this question, this article focuses on the concepts and theory of those Polish artists who have used radio in their artwork, either as the source of a particular type of sound or as a medium that collects and transmits the sound of its surroundings.

1. INTRODUCTION: CULTURAL CONTEXT OF THE USE OF RADIO AS AN INSTRUMENT

Derivatives of the Latin word *instrumentum* are present in a number of modern languages. Originally the word covered several semantic areas. In the most general terms, *instrumentum* specifies an object that is used for a particular purpose and in a particular way. With such broad semantic coverage, instruments and their associated actions can be found in such diverse domains as medicine (specialised instruments required to perform medical procedures), politics ('legal instruments' are documents that define required or prohibited actions) and, of course, music (instruments are used to make music and are characteristic of a given period, style, area or ensemble). Regardless of the details of the definition particular to the domain, all words etymologically derived from the Latin *instrumentum* are generally associated with actions that require precision in order to achieve a given purpose. The appropriate instrument is used with skill to help perform a task. We can therefore conclude that when an object is treated 'instrumentally', it becomes a means to achieve a goal.

Linguistically, words associated with the term 'instrument' are associated with the most common modes of action in which those instruments are used. Whenever a set of such objects is used, specific results are expected, and achieving those results is contingent on the functionality of the selected objects. In this sense, an instrument is much more than its physical and material manifestation. Looking at an object as an instrument means seeing the goal to be achieved by its use. This is a matter of teleology. An instrument is the starting point for an action in a given context. Defining the function of the instrument within its context also sets the limit of that function. Surgical instruments, for example, have strictly defined features and strictly defined operating instructions. Within its own context any given instrument has a strictly defined scope of use.

What do we expect from a musical instrument? Primarily to produce sounds that can form a musical piece. The use of a musical instrument is thus associated with a particular way of thinking about music, and this defines the use and identity of that instrument and its limits. Conventionally, a musical instrument is understood through its association with music. This inevitably leads to a never-ending discussion on what differentiates the musical from the non-musical. This discussion, intermittently renewed and broadened, has become a point around which musical history and theory turns. The aim is to determine those sounds that might be permitted into the domain of music and those other sounds that might be seen as outside the category of 'pure' or 'real' music. At this point, it is worth recalling the observation made by musicologists Carl Dahlhaus and Hans Eggebrecht that the question as to whether sounds are musical or not is not objective but historical (Dahlhaus and Eggebrecht 1985). Thus it can be argued that there is no such thing as non-musical music, but rather music that might not comply with a pre-defined, historically determined concept of music. In the context of this research, redefining music might be linked to a redefinition of musical instruments. Musical instruments generate sound, and those sounds are the material of music. Efforts directed at erasing the border between the musical and the non-musical were most prominent in the twentieth century, when the avant-garde strived to classify all sounds as musical, resulting in the classification of all objects as musical instruments. Part of this discussion and argument revolved around the radio as a musical instrument.

In order to understand the radio as a musical instrument, we need to pose two questions: 'What do

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we expect from radio?' and 'What is radio?' These questions are a suitable starting point for a discussion on radio as an instrument in art, particularly as they point to this teleological aspect of radio, which also varies with the times. Since the emergence of radio as a means of communication, there have been numerous, varied attempts to define its cultural meaning. From the classical analysis of Marshall McLuhan, who compared radio to the tribal drum (McLuhan 1994), from which it follows that radio creates a communal experience reminiscent of preliterate eras, to the observations of Günther Anders, who perceived the radio as a means of forging an 'entirely controllable' society of 'hermits' (Anders 1956). Thus radio is understood either as a medium leading to a collective re-tribalisation, or as one that creates solitary individuals enslaved by social convention. McLuhan's analysis of radio also had a significant impact on the study of oral traditions (Ong 1982), and on the reconstruction of the disembodied voice (Weiss 1995). Both of these studies draw attention to the fact that media generally associated with the visual sphere and predominantly focused on the experience of sight contributed greatly to the fragmentation of tribal cultures into highly specialised open societies. The radio is identified here as an important catalyst for further change, providing a medial space for experimentation where new forms of subjectivity might be constructed.

Seen from another, scientific perspective, radio can be defined as a particular type of wave. While radio waves cannot be directly observed by the naked eye, they do have an effect on the environment we are a part of. We understand them now as taking up a particular segment of a wider electromagnetic spectrum. Radio waves are those electromagnetic waves with the longest wavelengths, lowest frequencies and least amount of energy. Physics specifies them as having a length of between 30 cm and several thousands of metres. They travel through the air, and can be reflected by clouds or the ionosphere. These waves are utilised by satellites in space, and by standard radio and television transmission here on Earth. Devices such as short-wave radios, air traffic control systems, mobile phones and various remote-controlled objects all rely on them (Gregersen 2023). Scientific interest in the different types of such waves found in the environment has resulted in a renewed absorb in the very nature of sound, because only acoustic sound waves of a certain frequency are correlated with human perceptual capabilities. Sound waves, to the non-scientist so very different from light waves, require a more comprehensive approach, that is, if we are to fully account for the diverse world of sound, that fleeting, transient phenomena, aspects of which might be said to elude objective scientific methods and standards. A more comprehensive research approach in this context is related, among other things, to the fact that only a specific range of electromagnetic waves can be heard by humans, which does not mean that waves that are not directly perceptible do not have an effect on the human body and its surroundings. In addition to electromagnetic waves, our environment is also filled with acoustic sound waves, which are purely mechanical energy. While both electromagnetic and acoustic sound waves are fleeting, transient phenomena, only sound waves in the frequency range of 20 Hz to 20 kHz can be perceived by the human ear. Today we can measure, compare and even visualise both types of waves, but it is precisely because they cannot be directly perceived by the ear that they excite the imagination.

One particular experiment in acoustic wave visualisation has led to the design of a multi-sensory art experience. This project, aiming at the visualisation of acoustic waves in the medium of the actual sources, is a thought-provoking combination of art and science and is the result of a collaboration between Stefan Weyna and Wojciech Weyna. Stefan's profession involves the protection of industrial equipment from vibration, and Wojciech is a computer programmer. Together they demonstrated that with a novel technique of acoustic energy registration (in the form of sound intensity stream flow), dynamic acoustic phenomena can be visualised in a new and compelling way. Their method, deployed in this project, yielded a series of images and animations that present unique and unusual shapes derived from various sounds and the changes they go through, all of which could not be observed in any other way (Weyna 2006).

John R. Pierce and Edward E. David from Bell Telephone Laboratories, who popularised the science of sound, noticed in the 1950s that sound behaves in such a specific way as to require different methods of visualisation than those typically deployed in scientific experiments. They maintained that sound was a type of energy transmission. Sound transports energy from one place to another, in the same way that energy is transported by an arrow, running water or river flow. However, sound transmitted through the air that surrounds us should not be understood as a stream of air that flows from the origin of the sound to our ears, but rather as the waves the wind makes in a field of corn. The waves travel across the field, while the corn itself remains rooted in the ground (Pierce and David 1958: 22).

Over time the metaphors for the experiences associated with sound have been influenced by the various devices that have transformed our experience of acoustic waves – and chief among those devices are radio and its aerials. In the metaphorical domain, we view such devices as rooted in the ground and carrying the waves across its surface. Since the invention of

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radio, these vertical structures that reach for the sky have constituted a never-ending source of inspiration for artists who, fascinated by the achievements of this new technology, employed it to create and distribute new perspectives on the interaction between people and the world. This can be summarised by a quotation from the Australian art critic McKenzie Wark, 'We no longer have roots, we have aerials' (Wark 1994: 76). Regardless of the inspired product of those visions – which have included a plethora of innovative and varied art methods and practices – the experiences associated with radio have also had a profound impact on our way of thinking about music.

Obviously much of the history of music has passed without radio, and that has really only changed in the twentieth century. The radio was a real revolution in the way art and music were created, presented and received. Today, it would be difficult to imagine music without such a medium. Since the beginning of its existence, radio has been a natural channel for music, being the peak invention in music registration and its replaying, preceded by the phonograph, gramophone and tape recorder, with all their associated storage devices. Radio, intertwined as it is with sound-recording devices, led to an unprecedented popularisation of music – be it 'live' or recorded on some storage media – but it also led to the popularisation of other events designed for listening, as well as completely new forms of creativity. In this way, music, as a set of particular artistic practices, was completely redefined. The radio as such, from the very beginning of its presence as a medium in the sphere of communication, inspired innovative artistic projects, concepts and visions. These range from the utopian theory of Velimir Khlebnikov, who writing in the early twentieth century in his essay 'The Radio of the Future' referred to radio as 'the central tree of our consciousness' (Douglas 1990: 155), to the experiments of Hans Flesh, who created the foundation for a new form of radio podcasts (Hörburger 2006). Seen from this perspective, radio might be designated a multi-instrument, constantly going beyond the limits of each and every media that it is made up of.

2. RADIO AS AN INSTRUMENT: THE AVANT-GARDE

The history of art, and of music in particular, is full of examples that show the need to transgress contemporary standards and rules to achieve artistic goals. With music those restrictions include the orthodox use of instruments. Finding and developing innovative ways to play traditional instruments, constructing new instruments and reconfiguring old ones, taking objects from other cultural contexts and using them as sources of sound, these practices create an artistic plurality, they generate new directions for development, and what is more, they create a pressing need to redefine art to encompass all such activity.

Treating the radio as a musical instrument is symptomatic of avant-garde attitudes towards art and music. From the very first instant that radio receivers were used in order to extend the scope of the sources of sound in music, the need to revolutionise how we think about art became apparent. Famous pieces by John Cage, such as *Imaginary Landscape No. 4 (March No. 2)* from 1951 and *Radio Music* from 1956, have been interpreted and reinterpreted over and over again. They are prime examples of the most important aesthetic changes in twentieth-century music. Both pieces use radio as their only musical instrument. In the case of *Imaginary Landscape No. 4*, the conductor and – in the original concept – 24 performers, dial in the frequencies and volumes of 12 radio receivers. These frequencies and volumes are randomly selected by the composer, who is in turn guided by the *I-Ching* (The Book of Changes).[1] The score of *Radio Music* provides 56 different frequencies between 55 and 156 kHz (written down as numbers, rather than on the conventional five-line staff, as was also the case with *Imaginary Landscape No. 4*).[2] These are frequencies that are not fully reserved by commercial radio stations.

The significance of these pieces by Cage is multifaceted and goes beyond the scope of what we traditionally associate with music or art.[3] Deployed as a musical instrument, the radio receiver generates sounds that cannot be fully predicted. This rather obvious observation leads to a realisation within music of those avant-garde ideas that emphasise the need to re-evaluate the role and importance of the author or creator, as well as the relationship between composer, conductor and performer. Using chance as part of the creative process allowed Cage to redefine the traditional hierarchy of these relationships. It also propagated, in a creative way, an appreciation and sensibility for the aesthetics of noise that had begun with the early twentieth-century avant-garde movements. Radio, with its unforeseeable and not fully controllable sound effects, radically broadened the sources of sound available to music. Furthermore, these pieces by Cage were also significant in how they initiated a certain practice that continues to this day, a practice where composers feel free to include any sound available to them in their work, regardless of its

[1]Cage has described the methodology for creating this composition in detail (Cage 1961: 57–9).

[2]For a more detailed analysis of the *Imaginary Landscape No .4* score, see Valle and Casella (2016).

[3]Allen S. Weiss (1995) has a very interesting analysis, placing Cage's pieces in the broader context of the cultural analysis of radio.

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cultural context or aesthetic features.[4] As a result of all this, the traditional division between 'musical' and 'non-musical' sounds has been abolished.

A fascination with noise – including analogue radio receiver noise – from these avant-garde experiences is currently understood as much more than merely adding to the range of sounds that are now available to music. Here it might be germane to recall the fact that today's digitally generated noise is quite different from the analogue radio noise so characteristic of the twentieth century. The way noise is usually created today is as a product of digital media. This development has had a strong effect on radio. Modern radio receivers do not emit noise. The areas between the frequencies reserved for commercial radio stations are no longer a *terra incognita* to be freely explored and freely used. Radio noise territories are shrinking, narrowing into confined niches. In order to reach them one has to leave the commercial zone of currently manufactured and marketed devices and seek out, repair and remember that which has become marginalised by new technologies and the further developments of civilisation and the corporation.

3. RADIO AS AN INSTRUMENT IN POLISH ART

Cage's work had a swift and significant impact on artists in Europe. In 1970, Polish multi-media artist Krzysztof Wodiczko collaborated with the Hungarian-Polish composer and performer Szábolcs Eszténvi in the work *Just Radio Transistors*:

> In *Just Radio Transistors* ... they prepared a room with twelve transistor radios, a relatively new product in the [Polish] People's Republic, and a graphic score. An ensemble of musicians from the Section of Young Artists of the Association of Polish Composers was instructed to 'play' the radios. Eszténvi conducted the group. Although the composition specified volume and frequency, each radio was tuned to a different wavelength and so the result was disharmony. The collage of sounds was not unlike the effects of radio jamming. All the performers – including Wodiczko and Eszténvi – wore ear plugs. (Crowley 2012: 81)

In the context discussed here, radio noise and the wearing of earplugs were symbols of resistance against the forms of communication and participation dictated by the emerging, media-dominated culture, imposed and controlled by the then communist government. Another Krzysztof Wodiczko experiment utilising radio receivers was his work *Personal Instrument* (1969). In collaboration with Polish Radio's Experimental Studio (SEPR) in Warsaw, the artist constructed a 'headphone' and a pair of gloves, the latter incorporating sensors. Combined together they allowed for the amplification of surrounding sounds, as well as the control of their volume through gestures: 'A sensor on the glove turned the hand into a microphone, like a strange combination of Theremin's musical instruments and his espionage devices' (ibid.: 85). The artist's collaboration with SEPR in Warsaw is significant. This institution was firmly established in Europe and active throughout the 1960s and the 1970s. It is here, with the help of SEPR sound engineers, that Wodiczko created a metaphor for radio as a personal instrument. An instrument that could be used to achieve a conscious social isolation, an antithetical act considering the practice of the authorities in deploying such media for propaganda. *Personal Instrument* primarily points to the dangers of a world where we are surrounded by more and more microphones, a world that is broadcast and controlled by mass media. In addition though, it may be said to hide an incitement to use media, radio included, in one's own, personal way. T he world of sounds broadcast by radio is not limited to the words, music or effects designed and designated for transmission, but also includes those territories between the frequencies annexed by the authorities, as well as any random sounds from the environment that might be introduced into the transmission without institutional credentials.

This way of thinking, where noise is seen as a possible means of resistance against the mechanisms imposed by the authorities, is apparent in many art projects that emphasise social and political engagement. Donia Jourabchi demonstrated such an outlook during her residency at the Ujazdowski Castle Centre for Contemporary Art in Warsaw – a member of the *Sound of Culture – Culture of Sound* network of residences. Jourabchi's artwork focused on the politics of sound, noise and voice in the context of street demonstrations, and stressed the importance of radio noise in creating an appropriate attitude of mindful listening:

> Turn on the radio ... try to catch some noise ... listen to it ... carefully ... these fluctuations ... even from the most constant noise ... oscillate with our attention ... this is our listening position ... move the radio as if you are scanning the space ... listen to what affects the complexities of noise ... these different textures ... the filters and resonances of its acoustic articulations ... it is impossible to bring what we are listening to into words ... instead ... are we able to communicate our listening attention to each other through the articulation of noise itself? (Jourabchi 2016: 91)

The preceding examples represent the two basic ways of thinking about the radio as a musical instrument. The first gives aesthetic privilege to the sounds characteristic of the radio, specifically a radio receiver, with all the associated gestures that go along with them, such as increasing and decreasing the volume, searching for a frequency, exploring different frequencies, using different types of aerials, and moving or

[4]Another interesting analysis of the relationship between radio and music, including the treatment of radio as an instrument, is that of Jon Leidecker (2010).

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touching the aerials. Typically, these projects employ analogue radio receivers, although they might also use modern hybrids such as digital–analogue software-defined radio (SDR) systems.[5]

In such cases, where sounds from the radio are incorporated into the construction of a musical piece, those sounds might initially come across as mere sound effects, even if admittedly somewhat unique. However, such sounds should not be thought of as just aesthetic 'ornaments' or as simple ready-made components within a broader musical composition. Rather, they should be understood as elements rooted in a more complex structure made up of cultural, psychological and artistic aspects. As Jean-François Augoyard and Henry Torgue have described in their research, sound effects indicate four important psycho-sociological processes:

> Sound marking of inhabited or frequented space; sound encoding of interpersonal relations; symbolic meaning and value linked to everyday sound perceptions and actions; and interaction between heard sounds and produced sounds. These four processes are common not only to everyday, non-specialised sound experiences but also to those that take place in a space filled with disturbing noise or music. (Augoyard and Torgue 2005: 7–8)

Noise together with all the other sounds generated by radio receivers are also connected to these sociological and psychological spheres of influence mentioned by Augoyard and Torgue. In music these sounds demonstrate the tension between integration, where the various sources of sounds are treated as equally viable elements of the overall structure, and disintegration, which results from the association – deeply rooted in the culture – between radio noise and complex symbolic or metaphoric references to the unforeseeable or the imperfect. Thrown into this mix is also a simple nostalgia for the analogue. This complex set of references can be seen clearly in the curator project *Radio Noises* from the Antenna Non Grata microlabel. Musicians and artists invited to this project were asked to incorporate the sound of radio into their compositions. This collaboration culminated in an album featuring 10 tracks that demonstrate a variety of methods for incorporating the sound of radio into the structure of a musical piece.[6] Some of them might be seen as attempts to revive the sounds characteristic of early radio receivers commonly used in the past but no longer present in contemporary media culture. Others were experiments that attempted to find a common acoustic field for radio noise and electronic sounds.

Another way of thinking about the radio as a musical instrument goes beyond the structural thinking that focuses on sound effects, and instead treats the radio as a medium that transmits the surrounding soundscape. In this instance, radio is defined as a set of microphones connected to an appropriate technical system for internet transmission. The artist here is no longer a composer but rather a designer of such a technical apparatus and its software, who then goes on to select the surroundings in which to capture the sound. Contrary to an internet radio, which transmits previously prepared and designed content, this type of radio is a unique realisation of the avant-garde idea of extending the limits of music as far as possible. The sounds present in a given location become music because of the way in which they are being listened to. From this perspective, radio becomes an instrument that combines the incessant and unforeseeable sounds of the environment with refined – but also unforeseeable – ways of listening. One example of such a project is *Mikrofon w Puszczy Zielonce*.[7] In this work a microphone was placed on the border of the Zielonka Forest National Park. This is a very diversified area, where civilisation and an untamed nature interconnect. According to the artist, Krzysztof Piechota, this project has no particular aim. Leaves rustle, birds sing, there is the sound of rain falling, and the monotonous murmur of distant civilisation. These sounds have a relaxing and calming effect. The weather events stimulate the imagination. The sound of people might lead us to ponder the negative effect of humankind on the environment or the issue of sound pollution. Audio transmission without imagery makes people much more sensitive to sound. Listening to a constant transmission of a soundscape seems to signal a rebirth of the avant-garde ideas of John Cage, who believed that it is the way you listen that defines music rather than any previously composed set of sounds. From this perspective, it might be said that radio is a medium for transmitting the *musica mundi*, a composition of the many and varied soundscapes undergoing their respective cultural and natural transformations.

The *Mikrofon w Puszczy Zielonce* project, paying no heed to the commercial dictates of modern media, is in harmony with Hildegard Westerkamp's idea of the 'radio that listens'. Westerkamp describes how the radio might become an instrument of profound experimentation with the sounds that surround us. During her 'soundwalking' she discovers qualities of sound that usually remain unnoticed by everyday listening practices. In this environment the radio as an instrument becomes a medium that constantly listens and transmits the captured soundscape, as well as a

[5]One of the largest modern websites with links to numerous SDR radio stations can be found at: www.websdr.org (accessed 6 April 2023).

[6]See https://antennanongrata.bandcamp.com/album/radio-noises (accessed 10 April 2023).

[7]See https://heterodyne.eu (accessed 11 April 2023).

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tool that shapes the imagination and broadens the scope of non-visual experience:

> Imagine radio that instead of numbing us to the sounds, strengthens our imagination and creativity; instead of manipulating us into faster work and more buying, inspires us to invent; instead of fatiguing us, refreshes our acoustic sensitivity; instead of making us ignore thoughts and surroundings, stimulates listening; instead of broadcasting the same things again and again, does not repeat; instead of silencing us, encourages us to sing, to speak, and make radio ourselves; instead of merely broadcasting at us, lets us listen through it. (Westerkamp 2016:15)

4. CONCLUSION

Radio and its associated devices and techniques of recording and playing sounds, together with the art projects that make use of them, have left their mark on the development of art. This can be seen not only in music, but also in the art of creating sound that goes beyond the traditional boundaries of music as conventionally understood, that is, creativity based on paradigms that are deeply rooted in music culture, such as musical notation or the composition of traditional, instrumental forms of music. There is a certain paradox in the relationship between radio and music. On the one hand, radio made a colossal contribution to the popularisation of traditional forms of music, while on the other, it introduced into music different aural phenomena that had previously been seen as contradictory to music, such as various colours of noise and musical pieces without the traditionally defined structural elements, such as melody, harmony or rhythm. Musique concrète electronic music and its associated forms of radio drama not only created a new connection between radio and music, but also resulted in new forms of creativity each with their own sets of rules. Within these new forms the boundary between composer and performer, as well as that between musical and non-musical sounds, has been blurred. The sounds of everyday life and the electronic sounds generated by devices associated with the radio – an important electronic multi-medium in the sphere of communication – irreversibly changed our thinking towards sound and the possibilities of its modification.

In order to discern the multiple aspects of the network of mutual relationships between radio and music, the traditional way of thinking about radio as a medium that documents and broadcasts pre-designed content needs to be replaced by the idea of a multi-medium that generates new trends in art and new ways of thinking about music, in the context both of its composition and of its creative reception. In the context of contemporary art experiments, the radio functions as a multi-instrument, which on the one hand helps to generate and modify existing sounds – including those transmitted by the cultural industry – while on the other delivering constantly changing soundscapes, as well as the possibility of exploring the unforeseeable interference that occurs in between the frequencies used by commercial media. The examples we have described show that radio as an artistic phenomena is both an annexation of specific territories within the media and a critique of its content, all of which follows from the standardisation of the media. The non-standard use of the radio and the aesthetic valorisation of these activities can therefore be read as a kind of incitement to practice new forms of expression by freeing oneself from the orthodox processes and strategies for engaging in the audiosphere as dictated by mainstream media.

REFERENCES

Anders, G. 1956. *Die Antiquiercheit des Menschen. Über die Seele im Zeitalter der zweiten industriellen Revolution*. Munich: C.H. Beck.

Augoyard, J.-F. and Torgue, H. (eds.) 2005. *Sonic Experience. A Guide to Everyday Sounds*. Montreal: McGill-Queen's University Press.

Cage, J. 1961. *Silence*. Middletown, CT: Wesleyan University Press.

Crowley, D. 2012. Sounding the Body Electric. In D. Crowley and D. Muzyczuk (eds.) *Sounding the Body Electric. Experiments in Art and Music in Eastern Europe 1957–1984*. Łódź: Muzeum Sztuki.

Dahlhaus, C. and Eggebrecht, H. 1985. *Was ist Musik?* Wilhelmshaven: Heinrichshofen.

Douglas, Ch. 1990. *Velimir Khlebnikov. The King of Time. Selected Writings of the Russian Futurian*, Cambridge, MA: Harvard University Press.

Gregersen, E. 2023. Radio Wave. *Britannica*. www.britannica.com/science/radio-wave (accessed 27 October 2023).

Hörburger, Ch. 2006. Hörspie. *Media culture online*. www.lmz-bw.de/fileadmin/user_upload/Downloads/Handouts/hoerburger-hoerspiel-swr.pdf (accessed 27 October 2023).

Jourabchi, D. 2016. Notes on Radio Experiments. In K. Marciniak (ed.) *Warsound*. Warszawa: Centrum Sztuki Współczesnej Zamek Ujazdowski.

Leidecker, J. 2010. Radio Music. *Issuu*. https://issuu.com/macba_publicacions/docs/qa_03_leidecker (accessed 10 April 2023).

McLuhan, M. 1994. *Understanding Media: The Extensions of Man*. Cambridge, MA: MIT Press.

Ong, W. J. 1982. *Orality and Literacy*. London: Methuen.

Pierce, J. R. and David, E. E. 1958. *Man's World of Sound*. New York: Doubleday & Company.

Valle, A. and Casell A. 2016. Imaginary Landscape No. 4: Study and Annotation of the Score. *Proceedings of the XXI CIM Colloquio di Informatica Musicale*. www.academia.edu/28855879/Imaginary_Landscape_No_4_study_and_annotation_of_the_score (accessed 27 October 2023).

https://doi.org/10.1017/S1355771823000596 Published online by Cambridge University Press

Wark, M. 1994. *Virtual Geography: Living with Global Media Events (Arts and Politics of the Everyday)*. Bloomington, IN: Indiana University Press.
Weiss, A. S. 1995. *Phantasmic Radio*. Durham, NC: Duke University Press.
Westerkamp, H. 2016. Radio that Listens. In A. Kil-Matlak, R. Losiak, R. Tańczuk and S. Wieczorek (eds.) *Audiosfera. Studia*. Wrocław: Oficyna Wydawnicza ATUT.
Weyna, S. W. 2006. *The Shapes of Sound. Acoustic Wave Flow Visualizations in a Real Medium*. Szczecin: Zapol.

https://doi.org/10.1017/S1355771823000596 Published online by Cambridge University Press