

Binaural and Ambisonic Sound as the Future Standard of Digital Games

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Tomáš Farkaš is a lecturer at the Faculty of Mass Media Communication at the University of Ss. Cyril and Methodius in Trnava. His research has been centred on film music and sound, especially in the horror genre, which was also the subject of his dissertation paper. Horror genre and its functions in a broader context, in general, have been the subject of many of his research papers. Currently, his main research interest is mostly in sound design, different recording techniques, and studying auditive aspects of digital games. He also focuses on his own music and field recordings.

ABSTRACT:

The author of this study suggests an idea that the auditive element of digital games is soon going to be one of the most important factors influencing their overall success, popularity, and originality. He analyses the phenomenon of binaural and ambisonic sound, its evolution and uses in the context of modern audio-visual work, primarily focusing on games. The auditive component and its increasingly important role are analyzed in connection with the graphic design of games, virtual reality, as well as the popularity of specific games. This paper also focuses on audio-games, the use of binaural sound (which was first used on a large scale in *Hellblade: Senua's Sacrifice*) and various hybrid digital games, which are balancing between classic games and audio-games. Argumentation is based on an assumption that binaural sound is the way to ambisonic sound, which (within the context of the immersive and interactive character of digital games) predestines the new standard and shows an entirely new way of creating and using digital games at the same time. All of this is reflected in the context of the graphic design of digital games and their future.

KEY WORDS:

ambisonic sound, binaural sound, difficulty, digital games, film, graphics, sound.

Introduction

We can occasionally observe that certain types of media have one very interesting common feature: one of their specific elements is always at the front, evolving faster and better, while other parts have to catch up with it. In most cases, the reason is an actual technology being on a higher or lower level of development. This study's primary focus is the auditive aspects of digital games. However, there is a specific paradox to be mentioned right away at the beginning. Digital games as a medium are most frequently compared to cinematography. Although many researchers refute this kind of comparison, it is easy to see the similarities. Both digital games and movies are visual – at first sight at least. Cinema has evolved from photography (which is – simply said – represented by two-dimensional pictures) and its first steps in the context of technology were primarily visual. Although digital games have slightly different “silent era” (S. Horowitz and S. R. Looney mention era between 1940 – 1970, by the end of which creative hardware engineers figured out ways to make the earliest computer chips generate primitive sounds and effects),¹ they had similar a start as movies. Their visual execution quickly moved ahead of their auditive element. This way, our eyes were stimulated much sooner and more effectively. We can see this kind of evolution as completely natural until we confront it from a little deeper and more detailed viewpoint. M. Chion says human beings are *vococentric*.² Simply said, that means that our sense of hearing is nearly as important as our sight. For example, we respond to the sound of a human voice and its general frequency spectrum much more sensitively than to other sounds. Hearing also fulfills the role of a physi-

1 HORROWITZ, S., LOONEY, S. R.: *The Essential Guide to Game Audio. The Theory and Practice of Sound for Games*. New York : Focal Press, 2014, p. 21.

2 CHION, M.: *Voice in Cinema*. New York : Columbia University Press, 1999, p. 6.

cal anchoring of sounds in space in a way and gives objects their space/time dynamics. Of course, sight is not hanging behind. It has similar abilities – it distinguishes human faces much faster, notices only a slight movement etc. Even though, the auditive element of both digital games and movies was always lagging behind for decades.

While meditating on sound in games, U. Reiter writes that perceived quality of in-game audio is not a question of audio quality alone. As audio is usually only a part in an overall game concept consisting of graphics, physics, artificial intelligence, user input, feedback and so forth, audio has been considered to play a relatively minor role in the overall experience that a game provides. Consequently, a lot of effort has been put into providing near photo-realistic representations of (virtual) game scenarios to the player, but only little into audio.³ In other words, the way we experience a specific digital game is often not about how good or bad audio or graphics are, but literally the other way round – sometimes both of these can be of low quality, but we love the game as a whole anyway. M. Chion implies something similar when he writes about an *added value* in cinematography. It is partly bilateral (the image also influences the way we perceive sound). In a cultural situation of visio-audition, however, such as a concert, where we traditionally focus our conscious attention on what we hear, added value functions primarily in the other direction. The sight of an energetic gesture by a musician will make us hear a more powerful sound.⁴ When describing the relationship of visual and auditive elements in digital games, G. King and T. Krzywinska write that qualities of vision and sound are usually the most potent sources of impressions of presence in games.⁵

How is it possible then, that from the release of the first game with sound (S. Horowitz and S. Looney list Pong from 1972⁶ as the first game with sound), only *now* the filmgoers, gamers or scientists are carefully starting to talk about the so-called “golden era of sound”? From a certain point of view, a question like this opens an interesting issue dealing with our tendency to be stimulated primarily by visual impulses. We could explain this the pragmatic way. Just like in cinema, where we had to wait several decades for superior microphones, that would allow recording of actor’s voices or singing, digital games were likewise technologically dependent on the development of faster computer chips, sound cards etc. Nevertheless, if we focus on binaural sound, we can paradoxically trace its evolution even before the era of the first films with sound.

It’s not Just Stereo – Binaural Sound

There are several reasons why we have decided to incorporate the phenomenon of binaural sound in this study. One of them is related to a simple fact that human beings have binaural hearing. It is natural for us to listen to sounds with two ears and as D. M. Huber and R. E. Runstein write, although one ear can’t discern the direction of a sound’s origin, two ears can. This capability of two ears to localize a sound source within an acous-

3 REITER, U.: Perceived Quality in Game Audio. In GRIMSHAW, M. (ed.): *Game Sound Technology and Player Interaction. Concepts and Developments*. New York : Information Science Reference, 2011, p. 153.

4 CHION, M.: *Film, A Sound Art*. New York : Columbia University Press, 2003, p. 213.

5 KING, G., KRZYWINSKA, T.: *Tomb Raiders and Space Invaders. Videogame Forms and Contexts*. London : I. B. Tauris, 2006, p. 109.

6 HORROWITZ, S., LOONEY, S. R.: *The Essential Guide to Game Audio. The Theory and Practice of Sound for Games*. New York : Focal Press, 2014, p. 23.

tic space is called *spatial* or *binaural localization*.⁷ This can be easily explained by an example: when we hear a specific sound from our right side, the frequencies of this sound (mainly midrange and treble) arrive faster at our right ear than at the left one. Because of the obstacle that our head is, sounds that get to our left ear first have to overcome a series of reflections manifested in latency. Binaural recording is a unique way of recording stereo in which a simulated human head, with microphones where the ears normally go, is used to record the signal and listening is done with headphones. This method can produce a convincing recording of a sound field. Unfortunately, there is one large drawback: it works poorly when reproduced on speakers. Recently, systems have been developed that use digital signal processing to render the effect on loudspeakers, but the system works only for a small listening area and requires the listener to remain stationary.⁸ The difference between binaural sound and classic stereo (or a two-channel sound) resides in the consideration of each ear separately in respect to the sources of sound. This applies to sound reproduction as well.

So far, we have used the word “paradox” several times. In connection with the before-mentioned silent era of movies and digital games, it can appear as paradoxical that the first binaural recording (or reproduction more precisely) was realized in 1881 – hence much sooner than anyone could even contemplate about any movie era, not mentioning the fact that digital games didn’t even exist. This binaural transmission was demonstrated by inventor Clement Ader, who used pairs of microphones in front of the stage of the Paris Opera, sending signals to left and right earpieces of listeners elsewhere in the city. Note ‘pairs’, plural: this was in the days of the single-point-to-single-point telephone, before multicasting.⁹

Even though this technology pre-existed movies and digital games, it was not successful – neither telephones (which have remained mono-aural to this day) nor the movie industry had adopted it at that time. Of course, as a technology, the binaural recording was not left “dead”. It just stayed at a minor level of use. Later on, it started to be used in some of the radio broadcasts (for example BBC Radio 4) and in particular, radio plays. Forasmuch as this technology required the use of stereo headphones, which were invented as late as 1952, there was logically not a big demand. The first binaural microphone sets, as we know them today (artificial human head with microphones in ears), appeared in the 1970s’. Soon a few pop music albums showed up, using this technique for capturing instruments. It took several decades for headphones to be actually mass-produced and we could easily say that only during the last 20 or so years, headphones have been actually massively used, which created the demand for quality binaural sound again. When talking about headphones, it should be mentioned that they overall produce a much more intensive listening experience. They isolate us from the surrounding environment (of course, that depends on their construction and whether they are open or closed), thus creating bigger immersion. We could demonstrate this fact by an explosion of the popularity of the ASMR (Autonomous Sensory Meridian Response) community in recent years. ASMR recordings work exclusively with binaural sound only and have the capability to induce an equivalent of so-called auditory-tactile synesthesia. This means that when specific sounds (recorded binaurally) are presented to some people, they actually feel physical sensations or excitement in different parts of their body.¹⁰

7 HUBER, D. M., RUNSTEIN, R. E.: *Modern Recording Techniques*. Oxford : Focal Press, 2005, p. 62.

8 KADIS, J.: *The Science of Sound Recording*. Oxford : Focal Press, 2012, p. 95.

9 FOX, B.: Early Stereo Recordings. In *Studio Sound*, 1982, Vol. 24. No. 5, p. 36.

10 NAUMER, M., VAN DEN BOSCH, J. J. F.: Touching Sounds: Thalamocortical Plasticity and the Neural Basis of Multisensory Integration. In *Journal of Neurophysiology*, 2009, Vol. 102, No. 1, p. 7-8.

Alongside the development of different recording techniques, it is also interesting to watch the development of the graphic design of digital games, or rather how this development was perceived. In an article from 2001, editors of GameSpot magazine ask the question “How important are graphics to games?” in it. Today, in 2018, it is extremely interesting for us to read all the answers of interviewees, although to find the connection with sound can be a bit tricky. Among other people, one of the asked was Jake Simpson, the lead programmer of then Raver Software. Nearly all the answers tended to suggest that graphics is only somewhat important to games. Simply said, visual presentation of digital games was primarily considered as an element, that should draw the initial attention of a player or support the narrative (of course, the narrative is important in the context of the game genre). One of the conclusions of this article was that sophisticated visual effects were mainly a market’s demand connected to all of the new and (then) powerful hardware. However, before the introduction of 3D acceleration, or at least before the explosion of three-dimensional games, graphics weren’t as important, and it was fairly easy to look past a game’s ugly exterior if it had solid gameplay.¹¹

This study is trying to point out to a contrast between the extremely fast development of visual representation of digital games (cinema, in this case, serves as an ideal supporting point), somehow automatic demand for good graphics and a fact, that an actual good quality sound existed at the time when games hadn’t even dreamt of good graphics. From a certain viewpoint, we could argue that one of the reasons for this could be an audience/users and their own evolution. Filmgoers of the 21st century can hardly even imagine the way audiences of the late 19th century perceived the first movies. In a similar fashion, we can hardly picture the excitement of the first digital game players, who were fascinated by utterly primitive graphics and the simplest level of interactivity. However, both of these “audiences” (filmgoers and gamers) grew with their favorite mediums. Thus it is only logical to expect a shift in preferences of both groups – there are many specific qualities to both mediums which people can be focused on. At this point, the importance of audio could come out as being an important part of both digital games and movies. It was always “on the same boat”, but consistently kept back. Now, the graphic design of digital games has undergone a huge transformation in quality, including the ever-growing palette of virtual reality (VR) devices. Nevertheless, the auditive component is slowly starting to play a bigger role in the same context. With a bit of exaggeration, we could even argue that audio is in the lead. While the developers of VR devices struggle to create the best, the simplest, most effective, portable, comfortable and - last but not least – mass-produced and available solution, audio has found its solution a long time ago. There is a phenomenon called *ambisonic sound* that appears to go arm in arm with VR and is just starting to be interesting. We assume that this type of sound could be the new audio-standard and we even dare to claim that it could also provide a completely new formal approach to game design.

Ambisonic Sound, Audio-Games and New Approaches

The ambisonic microphone allows a greater post-recording manipulation of sound. It consists of four separate directional capsules mounted in the faces of a tetrahedron

11 QOTW: *How Important Are Graphics to Games?*. Released on 26th June 2001. [online]. [2018-10-10]. Available at: <<https://www.gamespot.com/articles/qotw-how-important-are-graphics-to-games/1100-2693475/>>.

(three-sided pyramid) so that they aim at the odd-numbered corners of a cube: the elements are left-front up, right-rear up, right-front down, and left-rear down. These signals can then be matrixed to produce a wide range of simulated pairs and some ambiance.¹² Simply said, this type of microphone is able to record the sound or atmosphere of a specific place in all directions, not just left or right, but also up, down, rearward etc. We could even say that this microphone is a kind of extension of so-called middleware, which is software that first appeared in late 90’s of the 20th century. For sound designers or composers, this software was a way how to gain even bigger control over how game audio behaved in digital games. Why was middleware needed? Music and sound designers and programmers developed middleware so that designers and composers could gain more control over how their audio was used in games. Middleware is based on the idea that the digital game is an interactive medium, so all audio elements within the game should be interactive as well.¹³ The main advantage of ambisonic recording is a simple fact – with the help of specific plugins and technologies, we can get four separate audio tracks which we can then use in a precise simulation of space. We can also easily apply a technique which tracks our head while it moves. In comparison with binaural sound then, ambisonic recording allows us to utilize head tracking, which is a technology scanning the movement of our head (for example in the context of VR) and this way it creates nearly perfect immersion.

We could describe ambisonic sound as an auditive version of 360-degree videos, which started to be widely used and available around 2015 when YouTube started to support this format. In these videos, we can achieve similar results as with ambisonic recording – using a set of several video-cameras (recently, special cameras allowing this technique only with one device appeared on the market) we can record a video, in which we can rotate seamlessly in all directions. One of the problems with these videos, in the beginning, was that the soundtrack was usually only in stereo. Newer devices such as GoPro Fusion (which appeared on the market by the end of 2017) are already capable of recording 360-degree audio as well. Probably one of the most interesting technological creations these days is the NT-SF1 microphone, which was created with collaboration between Soundfield (a company considered to be a pioneer in ambisonic recording) and Rode (one of the most widely known microphone producing companies). It is interesting to mention that this kind of sound recording and streaming was previously used in big football stadiums as one of the broadcasting microphones. Of course, in the context of digital games, this kind of technology is only interesting after it is available at the consumer level.

This microphone is capable of the exact recording technique as described above. A sound recording is captured into four separate tracks. As a part of a package, special software is provided, which is able to manipulate these four tracks any way we need. Thus, it is not only possible to create a 7.1 surround mix (current level of Dolby Atmos system mostly used in cinemas), but also incorporate head tracking and create a completely immersive video that imitates the movement of our head (or a mouse cursor) while modulating the sound accordingly. In the context of digital games, this means the way to complete and perfect immersion – this way we can literally put a player into a game on an auditive level. If we remember the beginning of this article, specifically the part about how physical the role of sound can be, it is easy to imagine the effectiveness of ambisonic sound. Within the frame of digital game evolution, this technology is still only at the beginning. There are already several games where sound plays a primary role. *Hellblade: Senua’s Sacrifice*¹⁴ was

12 KADIS, J.: *The Science of Sound Recording*. Oxford : Focal Press, 2012. s. 95.

13 HORROWITZ, S., LOONEY, S. R.: *The Essential Guide to Game Audio. The Theory and Practice of Sound for Games*. New York : Focal Press, 2014, p. 47.

14 NINJA THEORY: *Hellblade: Senua’s Sacrifice*. [digital game]. Cambridge : Ninja Theory, 2017.

released on PlayStation 4 in 2017 and is the first “big” game which fully incorporates the possibilities of binaural sound. The creators of this game not only created a totally immersive game world but also managed to use this technique as a way to portray the gradually evolving psychosis and hallucinations of the main character. The team responsible for this game (Ninja Theory) went even further and consulted the symptoms of psychosis with neuroscientists. There is another phenomenon, which we haven’t discussed yet – audio-games. These games exist either with no graphics at all or use only basic/minimal graphic design.

Audio Games

Audio games as a concept have been around for many years. The first reported audio game sold was Atari’s *Touch Me*¹⁵ in 1974. This was a memory game where a series of tones would play, and the user tried to recall the tone sequence and press appropriate buttons to mimic it. Although it was also a visual game (lights flashed in concert with the tones), the game was simple enough that it could be played by people as a pure audio game.¹⁶ There are a lot of games we could easily misinterpret as audio games. Games like *Guitar Hero*,¹⁷ *Parappa the Rapper*¹⁸ or *Audio Surf*¹⁹ are based on sound and rhythm, but they all have graphics and would be actually unplayable without them. In the 1980s a number of interactive fiction or adventure games were being developed. These involved users being given text descriptions of a location (“you are in a large cave” or “you are on the bridge of a spaceship”, etc.) The user could then enter text to say what action they wanted to do (“go north”, “pick up gun”, etc.) The gameplay normally involved a number of puzzles presented in descriptions and solved by entering a series of commands. By connecting these games to a text-to-speech interface, they could be made playable by sound only. Like many audio games, these were designed for people who were blind or partially sighted. It can be thought of as an interactive radio drama. The user listens to segments of the story and then the game chimes and he can make selections which decide how the plot unfolds. *Audio Space Invaders*²⁰ was a Pc game that used 3D ambisonics. The gameplay consists of shooting flying invading aliens and does not require a graphical interface to be played. Much of the game is based on the user hearing where the enemy is: to their left, right, in front, behind. Different sounds represent different types of enemy ships, the Doppler effect²¹ indicates a ship’s direction of movement, and pitch represents closeness to the player.²²

The horror series *Papa Sangre*²³ (2010 – 2013) and the science fiction *Nightjar*²⁴ (2011) brought more popularity to this genre. Both utilized binaural sound in a large extent, the player had to avoid different obstacles, solve puzzles and gather musical notes.

15 ATARI: *Touch Me*. [digital game]. Sunnyvale, CA : Atari Inc, 1974.

16 KIRKE, A.: When the Soundtrack Is the Game: From Audio-Games to Gaming the Music. In WILLIAMS, D., LEE, N. (eds.): *Emotion in Video Game Soundtracking*. Cham : Springer International Publishing, 2018, p. 66.

17 HARMONIX: *Guitar Hero*. [digital game]. Cambridge, MA : RedOctane, 2005.

18 NANAON-SHA: *PaRappa the Rapper*. [digital game]. San Mateo, CA : Sony Computer Entertainment, 1996.

19 FITTERER, D.: *Audiosurf*. [digital game]. Bellevue, WA : Valve Corporation, 2008.

20 For more information, see: MCCRINDLE, R. J., SYMONS, D.: *Audio space invaders*. Reading : The University of Reading, 2000.

21 Remark by the author: Doppler effect is based on a change of frequency or a length of a sound wave in relation to an observer. The most typical example is a sound of a car horn passing around.

22 KIRKE, A.: When the Soundtrack Is the Game: From Audio-Games to Gaming the Music. In WILLIAMS, D., LEE, N. (eds.): *Emotion in Video Game Soundtracking*. Cham : Springer International Publishing, 2018, p. 66.

23 SOMETHIN’ ELSE: *Papa Sangre*. [digital game]. London : Somethin’ Else, 2010.

24 SOMETHIN’ ELSE: *The Nightjar*. [digital game]. London : Somethin’ Else, 2011.

Both also used voice commentary as the way to navigate throughout the story. There is also something like an intermediate level between audio games and classic digital games. Games like *Devil’s Tuning Fork*²⁵ (2009) or *Lurking*²⁶ (2014) use minimalistic graphic design and a navigation system that resembles echolocation of dolphins. These games also make use of a microphone connected to the computer, responding to a player’s sounds. This way the sounds add to the effectiveness of the general atmosphere of the game (both games – especially *Lurking* – are horror games) and create even bigger immersion effect (in *Lurking*, all the player’s sounds lure enemies towards his or her location). We mention all these games also because there is another important element which we haven’t discussed yet. In the context of this article, the *difficulty* plays an interesting role. Should we consider this factor through a prism of graphics or visual portrayal of the game, interesting results could emerge, involving players as well. In 2012 Dylan Viale – then a fifth-grader – created a game called *Quacky’s Quest*.²⁷ It was based on a classic labyrinth and collecting diamonds. His biggest motivation was to create a game that would make his blind grandmother be able to play with no problems. He changed the whole concept and started working on an audio game. One of his conclusions is very important to us: during the process of testing the game, Dylan discovered that blindfolded players were actually slower at the game than his blind grandmother, who is used to taking cues from sound.²⁸ That shows us one very interesting fact: with the coming of audio games, there comes also a new kind of challenge and difficulty. In the next chapter, we reflect on the relationship of these factors – sounds, graphics, and evolution of technology.

Graphic Design of Digital Games in the Context of Sound, Difficulty and a New Challenge

People usually tend to say that digital games used to be much more difficult. This myth partly loses its “mystical” powers though, especially when we put it within the context of the simple fact that many games were made difficult mainly to make players to put more coins into the arcade consoles. But if we look deeper into this subject, we find that the general difficulty of digital games has actually really fallen and that many game developers are consciously simplifying all of the known concepts and focus primarily on a fluent flow of narrative, action, perfect graphics etc. Take the *Mass Effect*²⁹ series or *The Elder Scrolls*³⁰ for instance. We can observe this tendency in both series – branched menus with abilities and skills or more or less complicated crafting system – everything seems to be out of fashion. Recently, however, we could notice a slight return of higher difficulty

25 DEPAUL GAME ELITES: *Devil’s Tuning Fork*. [digital game]. Chicago, IL : DePaul Game Elites, 2009.

26 LURKINGGAME: *Lurking*. [digital game]. Singapore : Lurkinggame, 2014.

27 VIALE, D.: *Quacky’s Quest*. [digital game]. Martinez, CA : D.Viale, 2012.

28 COWEN, A.: *Success Story: A Video Game for the Blind*. Released on 24th May 2012. [online]. [2018-10-21]. Available at: <<https://www.sciencebuddies.org/blog/success-story-a-video-game-for-the-blind>>.

29 BIOWARE: *Mass Effect*. [digital game]. Redmond, WA : Microsoft Game Studios, 2007.

30 BETHESDA SOFTWAREWORKS: *The Elder Scrolls*. [digital game]. Rockville, MD : Bethesda Softworks, 1994 – present.

in digital games. *Dark Souls*³¹ was the name that resonated most vividly recently, a game from From Software, which discourages many players with its uncompromising fighting system and precarious world. This series (ended with its third installation in 2016) is interesting in the way of not telling the player anything, with the narrative being dominated by minimalistic *environmental storytelling*.³² In simplified words we can say that all the installments of these digital games (including *Bloodborne*,³³ made by the same team, in a slightly more horror setting) have one thing in common: most enemies and nearly all the bosses are able to kill the player on one or two hits and the usual methods of avoiding this kind of difficulty (for example *grinding*³⁴) simply don't work in this universe – a player simply has to master the fighting system of the game, making it the only way to actually finish the game. This series (gaining cult status already) has in a way paved the path for other games, which plucked up courage and increased their difficulty as well. Apart from digital games we could consider “clones” of *Dark Souls* (*Titan Souls*,³⁵ *The Surge*,³⁶ *Salt and Sanctuary*³⁷), there are - or are being made - many games that are inspired by it (*Nioh*,³⁸ *Lords of the Fallen*,³⁹ *Hyper Light Drifter*,⁴⁰ *Ashen*,⁴¹ *Blasphemous*⁴²). In other words, a demand for higher difficulty and complexity has suddenly appeared.

Of course, we shouldn't be surprised. We have to bear in mind that the player audience is evolving. It is logical to assume that a generation of players who grew up on difficult and more complicated digital games in the past simply needs a bigger challenge, which is often not included in AAA titles, even with difficulty turned to “hard”. We assume that – within the context of auditive aspects of digital games – it is exactly this feature that could fit into this equation. The sound could reveal a new type of formal approach implementing new kinds of difficulty in digital games. There are several arguments for this assumption. First and foremost it is very difficult to indicate any connection between the graphics and the success of the digital game. Game rankings that we can always look up on the portals like Metacritic.com show us that great deals of games longstanding at the highest rankings (from the viewpoint of players as well as critics) are actually games ten or even fifteen years old.⁴³ It is very difficult to talk about hi-tech graphics from this point of view because these digital games are obviously being celebrated for something completely different. If we would remember an analogy between games and movies, we could also find out some interesting things based on how for example the horror genre was perceived in recent years. Continual repetition of clichés, stereotypes and the same procedures all over again cannot be saved by the visual level of the movie. Contrariwise, it's the movies made with a minimalistic approach and accentuating sound that are rated as notable and progressive. Pushing the limits of image reproduction is likewise showing potentially dead ends.

31 FROMSOFTWARE: *Dark Souls*. [digital game]. Tokyo : Namco Bandai Games, 2011.

32 Remark by the author: Way of telling the story without dialogues or cutscenes, more focusing on hints and symbols player can see in the surrounding world, on its interaction with this world, exploration or details in which names and descriptions of items are inscribed or placed etc. If environmental storytelling is done right, there could be not a single cutscene and the player can put the pieces of story, atmosphere, NPC's behaviour together by himself.

33 FROMSOFTWARE: *Bloodborne*. [digital game]. San Mateo, CA : Sony Computer Entertainment, 2015.

34 Remark by the author: Repeating of some action, usually killing certain types of enemies over and over again resulting in gathering experience points easily, thus levelling up faster.

35 ACID NERVE: *Titan Souls*. [digital game]. Austin, TX : Devolver Digital, 2015.

36 DECK13 INTERACTIVE: *The Surge*. [digital game]. Paris : Focus Home Interactive, 2017.

37 SKA STUDIOS: *Salt and Sanctuary*. [digital game]. Seattle, WA : Ska Studios, 2016.

38 TEAM NINJA: *Nioh*. [digital game]. San Mateo, CA : Sony Interactive Entertainment, 2017.

39 DECK13 INTERACTIVE: *Lords of the Fallen*. [digital game]. Tokyo : Bandai Namco Entertainment, 2017.

40 HEART MACHINE: *Hyper Light Drifter*. [digital game]. Tokyo : Playism, 2016.

41 AURORA44: *Ashen*. [digital game]. Los Angeles, CA : Ananurna Interactive, to be published in 2018.

42 THE GAME KITCHEN: *Blasphemous*. [digital game]. Sevilla : The Game Kitchen, to be published in 2018.

43 Remark by the author: During the time this article has been written (October 2018) Legend of Zelda: Ocarina of Time is on the first rank.; NINTENDO: *Legend of Zelda: Ocarina of Time*. [digital game]. Kyoto : Nintendo, 1998.

The 3D movies boom which started with Cameron's *Avatar*⁴⁴ started to vanish after a few years and from the supposed-to-be future technology, only a bitter taste remained. The audience simply lost its interest in this new technology and just wanted a good movie. In a similar fashion, a 4K resolution (soon 8K) and HDR technology are pushing its way into our living rooms. But then again, their automatic success should be taken lightly. The way the human eye is constructed cannot be fooled and all the new ultra-high resolutions and artificial smoothing of images somehow bring up complete opposite reactions among specific parts of the audience. The so-called *soap-opera effect*⁴⁵ is but one of the many problems, although it can be turned off. The higher resolution of the image is rather a technological excuse for further pushing of the limits, but we barely bear in mind the ratio between our distance from TV and our ability to actually appreciate this kind of resolution. Of course, we wouldn't like to be those with torches and forks in our hands, calling for the end of all technologies. But the point is that as long as the movie is bad, not even 8K resolution is going to save its qualities, not mentioning the fact that most people nowadays have virtually no problem watching their favourite movies on a small screen of a notebook or even a smartphone. This is exactly the problem T. Walker mentions in the abovementioned article when he says that graphics play an important role in the initial appeal of a game and less of a role once a player has become familiar with the game.⁴⁶ We can similarly perceive the phenomenon of remakes of different digital games, which often get very mixed reactions. A recent example of this is *Shadow of the Colossus*,⁴⁷ which was originally released for PlayStation 2 in 2005 and at its time proved that digital games definitely can be considered as art. Now, after the complete reworking of graphics for PlayStation 4, we can assert that the new version indeed looks remarkable, but has paradoxically lost a great deal of the original atmosphere.

During her TedX presentation from 2012, professor and neuro-cognitive scientist D. Bavelier from Geneva University demonstrated how the players of 3D action games (or “shooters” if you will) have better sight on several levels compared to other people or non-gamers. Their ability to distinguish little details is better (for example, they have fewer problems with reading very small letters) and they also can separate many more shades of the colour grey. Also, they exhibited better and more effective reactions in experiments dealing with focus and differentiating between written words and their meanings. When meditating over the properties of binaural sound, F. Rumsey and T. McCormick claim that some people are better at localizing sound than others, and that the HRTFs (Head-related Transfer Function, in simple words the ability and response of the human ear to capture and locate a specific sound in space) of so-called “good localizers” can be used in preference to those of “poor localizers”.⁴⁸ When listening binaurally, the auditory events are less spatially *blurred* than in the monoaural case. For instance, two auditory events that are only 1° apart in azimuth can be discriminated binaurally for frontal sound incidence, while in monoaural listening the respective localization blur is at least 10 times larger. A higher spatial distinction in the binaural case also holds for elevation and distance. Further, in binaural hearing, the spatial extent of auditory events is more clearly defined, that is, there is a clear distinction between spatially compact and spatially diffuse ones.⁴⁹

44 CAMERON, J. (Director): *Avatar*. [DVD]. Los Angeles : Twentieth Century Fox Film Corporation, 2009.

45 Remark by the author: Latest TVs have an image-smoothing option, which actually causes all the movies (even the big blockbusters) look like they were filmed before 2000 with a handy-recorder.

46 QOTW: *How Important Are Graphics to Games?*. Released on 26th June 2001. [online]. [2018-10-10]. Available at: <<https://www.gamespot.com/articles/qotw-how-important-are-graphics-to-games/1100-2693475/>>.

47 BLUEPOINT GAMES: *Shadow of the Colossus*. [digital game]. San Mateo, CA : Sony Computer Entertainment, 2018.

48 RUMSEY, F., MCCORMICK, T.: *Sound and Recording*. Oxford : Focal Press, 2009, p. 484.

49 KOHLRAUSCH, A., BRAASCH, J., KOLOSSA, D., BLAUERT, J.: *The Technology of Binaural Listening*. Heidelberg : Springer, 2013, p. 2.

We assume that this greater focus on the auditive aspects of digital games could lead to similar positive effects on players among other things. Many of these effects cannot be observed yet, because game audio is just on its rise and most of the research has been focused primarily on the visual aspects of digital games. There is also a slight chance that players could possibly get to a point in the (near) future when they are oversaturated by visual aspects of games (which could be indicated by a recent return of pixel-art graphics) in a similar fashion to film audiences in the context of certain genres and stereotypes. It is, therefore, appropriate to start contemplating how the new processes in game audio could be used not just as a new formal approach, but as a teaching aid or a practice used for improving some of our senses (as D. Bevelier's experiments show us). Game audio offers many unexplored territories, which could bear not only a great deal of creative potential but also offer a space for the new and potentially positive effects of digital games on our senses and abilities.

Conclusion

The main goal of this paper was to lay out an idea that the auditive aspect of digital games presents so far unexploited possibilities which spread out on many levels. The first one and easily the one that is the most understandable resides in the large number of opportunities offered by audio on the level of creativity. Whether it is an aesthetics factor resulting from the physical properties of binaural and ambisonic sound, or in the number of ways that we can use its features as a conceptual element in an original digital game. The second level exists as a simple contrast between graphic design and game audio in the context of how these two behave within the frame of technological evolution and its perception by players/audiences. It is apparent that this topic is much more complex and it is hard to seize it in one small study, nevertheless, it is possible to argue that constant shifts of the visual aspects of digital games can be interpreted as secondary. Based on this argument, on the contrary, we can prove that audio has all the prerequisites to be the next "next-gen". Another level presents the possibilities of how game audio could actually improve different abilities of players. Based on the examples with graphics and gameplay being able to stimulate players to improve their sight, and based on similar experiments with human's ability to localize sounds in space, we assume that the more the auditive elements of digital games are going to be innovated and teamed up with new technologies, the more of the (positive) effects on players we will be able to observe.

Last but not least, the auditive element of digital games also offers space for exceeding the borders of a game's world. The example of *Hellblade: Senua's Sacrifice* shows us, how even a small team of game makers managed to raise awareness of psychosis and hallucinations using the binaural recording technique. There is no doubt that there is going to be many more attempts like this in the future and it is only a question of technology as to how these attempts are going to be executed. Nowadays different companies are trying to create fully 360-degree sound using speakers on a consumer level, which simply means that binaural and ambisonic sound will soon not only be the domain of headphones and VR. Perfectly immersive sound could be the next standard. With the help of artificial intelligence (taking care of localizing a person in an exact position in the room), this feature could mean the next step (not only) in the world of digital games, changing the way of working with narrative, gameplay, difficulty or space.

We don't say that there have been no games using similar concepts before. For instance, the auditive element has been recently very important in horror digital games (not

only as an aesthetical element but as one of the primary game concepts – we can observe this in the games like *Outlast*,⁵⁰ *Amnesia: The Dark Descent*,⁵¹ *Soma*,⁵² on a large scale in *Alien: Isolation*⁵³ or the online game *Dead by Daylight*⁵⁴) and in many action games. The player has to be aware of sound clues in digital games like *Splinter Cell*⁵⁵ or even *Counter-Strike*.⁵⁶ In the online game *PlayerUnknown's Battlegrounds*⁵⁷ one shot of a gun can reveal a player's position. We could thus say that audio (if we don't take into consideration the sound design as such) has been so far used mostly as an aspect determining the survival or localization of a player and/or enemy. We suggest that localization of whichever digital game object in space (or game world) is only the first of the many possibilities which are offered by the fully incorporated use of game audio. It is obvious of course that the visual elements of digital games haven't had their "last words" either. With the coming of technologies like *ray tracing* or pushing the limits of virtual and augmented reality, anything could be possible – but as we suggested in a previous chapter, game concept and gameplay always tend to outweigh the priorities of players, even though the initial experience with perfect graphics can be intense.

Even though this study is trying to present a rational argumentation, it also recognises the unpredictability of the market and of player's expectations or needs. It assumes though that the auditive element of digital games is one of the aspects which will expand in the near future and which will draw more and more attention from the player audience – not just on the level of sound effects or background but on the level of something that is changing the whole concept of digital games.

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