**“Microsound – The Audio Game” Commentary**

**Introduction**

‘Microsound – The Audio Game’ is a project which I have developed using JavaScript, and in particular the creative coding library p5.js. The objective of my project was to create a non-linear, generative, and interactive audio game inspired by the fundamental ideas explored by Curtis Road’s in *Microsound* (2004), namely that all sounds can be described as composite of small sonic particles or grains. I aimed to create an interactive project abstracting this concept in an engaging way. Audio games are an ‘emerging creative field… a crossroad between video games and computer music’ (Zénouda, 2012, p.1).

It's useful to define some of the terms which I will use throughout this commentary. Non-linear media refers to types of media which ‘provide many choices for players to make, and that every gameplay will be different’ (Collins 2008, p. 4). Collins definition here focuses particularly on video games as it is one of the most dominant form of media utilising the non-linear form. This being said, books, music, websites, and many other forms of media can also be non-linear and therefore in Collins’ (2008, p.4) definition the ‘player’ and ‘gameplay’ terms are interchangeable with others such as reader and read-through for a book and user for a website. Non-linearity is closely related to interactivity. Smuts (2009, p.66) states ‘that something is interactive for an individual if it responds in a way that is neither (1) radically random nor (2) almost completely controllable’. This is a concentrated definition of interactivity which highlights the importance of bilateral response between two interacting elements. Smuts (2009, p. 64) explains that ‘one does not interact with their car so much as they do with other drivers’.

Now I will explain the premise for my audio game. Users record audio into the game via their computers microphone. The audio is split up into small fragments or grains, length defined by user input (10-100 milliseconds). The user then has the ability to spawn in these grains in the game space by clicking them in. The user controls the initial position of each particle as they are generated at the point of click. Each particle is acted on by a ‘gravity’ force attracting them to the centre of the game space and ‘orbit’ to a degree around this. Particle’s playback their sound upon collisions with other particles and users have the ability to fire or project the particles through the space amongst other things.

**Context**

My audio game has context within a number of fields, for instance non-linear media in particular relating to music. Some of the first examples of non-linear music-related media are the musical dice games which gained popularity in Europe in the 18th Century such as

‘Der allezeit fertige Menuetten- und Polonaisencomponist’ (Kirnberger, 1757). Albini (2018, p. 395) describes how these games ‘made it possible for the person ignorant of music to write minuets, marches, polonaises… and so forth by selecting bits of prefabricated music through the use of chance operations’. This collection of works ‘is frequently cited as a precursor both to aleatoric music and algorithmic music’ (Vickery, 2011, p. 74).

Of course, my project also has a contextual relationship with the core theoretical idea of approaching sound as particles. Rocchesso and Mannone (2020, p. 292) explain how the physicist Denis Gabor used ‘quantum theory to shed light on subjective acoustics, thus laying the basis for sound analysis and synthesis based on acoustical quanta, or grains, or wavelets’. The key theory that linked the two fields ‘wave-particle duality…[is] a cornerstone of quantum mechanics... [and] states that all particles…have a wave-like property associated with them’ (Sutter, 2022). Thus, the concept of waves and particles are somewhat interchangeable. Therefore, ‘in Gabor’s view, all sonic phenomena can be decomposed into collections of sound particles on a timescale of 1 to 100 ms’ (Roads, 2003, p. 272). Roads (2004, p. 30) goes on to explore how this approach to sound allows ‘the composition of timbre, instead of with timbre’ due to this being a timescale on the limit of human perception and describes real life ‘interactions of microsounds’, such as, ‘the… spray of water droplets on a rocky shore… the hissing of rice grains poured into a bowl’(Roads, 2004, p.21).

Also, my project is situated with context within the field of audio games. Zénouda (2012, p.1) describes how audio games ‘manipulate… “a-musicological” representations (i.e., using symbols not normally associated with traditional musicology to manipulate and produce sound)’. This spans from interfaces for musical composition such as ‘Blob Opera’ (Li, 2020) to more traditional gameplay focused games with a preponderant sound dimension such as ‘Aura’, (*Aura Game*, 2015), an ‘exploration-based music game’ (Trinh and Cao, 2015). The majority of these interface-for-composition focused audio games, such as ‘Plink’ (*Dinahmoe*, 2011), limit players to a specific time frame (quantising notes to a BPM) and musical scale. Through approaching sound on a granular level, it has allowed me to create a project free from those restrictions capable of creating potentially more complex textural compositions. Nevertheless, my project is not the only example of this, Zénouda (2012, p. 5) describes Blue Yeti’s ‘musical drawing “Grapholine” system based on the transformation of sound samples… by granular synthesis’ (*enviedagir*, 2008).

My research models aspects of the physical world as a preponderant element of my audio game. There is key context surrounding this such as Conway’s game of ‘Life’ (Gardner, 1970, pp. 120-123). After initial randomness (or player determined input) this game follows a set of simple rules based on the life and death of cells (Bosch, 1999, pp. 594-596). It ‘mimic[s] the behaviour of life’ (Zenil, 2015, p. 112), and the evolution of populations of organisms. Artists have sonified the ‘Game of Life’ creating generative music. In one example, Arfib, Vaals, and Xue (2010, p. 109) describe ‘triggering sounds according to changes in the state of specified cells’. Taking this idea further, Filipczak’s (2017, pp. 11-13) ‘Passerine’ is a simulation of biological evolution where ‘virtual creatures… exist within a simulated physical environment’. Music is generated as the creatures collide with objects in their environment, interactions indirectly determined by their DNA (Filipczak, 2017, p. 17). Also, Filipczak (2017, pp. 13-15) details ‘Caasi’ (Figure 1.1) an ‘attempt to sonify variations in global physical forces…within a simulated physics world’. Modelling forces of gravity and air resistance, ‘tones are cued when particles collide with the edges of the screen’ (Filipczak, 2017, p.13). Using simulations allows for one way of creating music using bottom-up materialist and aleatoric approaches, design forms which are ‘the norm of natural beauty’ (Filipczak, 2017, p.25).

**Methodology**

In this section of the commentary, I’m going to discuss the process surrounding the creation of my project. I created my project using JavaScript in particular using the p5.js library. Part of the reason behind this was convenience. Matthew (2022) describes how the p5.js website has an editor ‘with built-in support and syntax highlighting’ meaning that ‘it’s easy to get up and running quickly’. JavaScript itself is a good choice as it’s extremely accessible and the industry standard for client programming supported by all modern browsers. Roberts and Kuchera-Morin (2012, pp. 64-65) describe how the flexibility of JavaScript make it well adapted for creative and artistic purposes.

Key in my project is the use of vectors and arrays. I have an array ‘particles[]’ in which each element contains a class or instance of the ‘Mover’ function which contains all of the data for a single particle (Appendix 2.1). The class defines a given particles position, velocity, and acceleration each as an independent vector at any given time and any force applied to that particle. I then have a number of functions which continually impact each particle to model physical forces. For instance, the ‘gravity’ force which is independent for each particle is formed via creating a vector calculated by the particles position related to the centre of the game world. This vector is then used as the parameter for the ‘Mover.prototype.applyForce’ function (Figure 2.2-2.3) for that particular particle. Essentially this vector is added to the ‘acceleration’ object in that particular particle’s ‘Mover’ class. The ‘Mover.prototype.update’ function is continually called in the draw function and vitally constantly updates the position/velocity of a particle depending on velocity and acceleration (Appendix 2.4). Sound is generated by a for loop pairing across the draw and ‘CollideSearch’ functions which continually checks the positions of particles against each other, if the two particles positions are equal then the respective particles sounds are played.

One of the ways by which I’ve intended to create an engaging audio game is generativity, upon creation each particles initial velocity is random within some defined limits. This is important because in games generativity, and the variation this creates in player experience, positively ‘influences user motivation to play’ (Lee and Jeon, 2017, p. 42). Also, I wanted users to experience a high level of interactivity. Probably the biggest example of this, the particle projection functionality, works by creating a vector using the positioning of the mouse compared to a particle that has been clicked on. This vector is then applied to the particle’s velocity upon release of the mouse using the ‘.applyForce’ function.

**Research Questions**

My first research question was: what extent is their benefit to using web-based audio games and other nonlinear interactive media as an educational tool to communicate musical ideas/understanding? Cairncross and Mannion (2010, p. 162) describe how key features of non-linear media being ‘user control over the delivery of information and interactivity can help learners come to a deeper understanding through supporting conceptualization and contextualization of the new material being presented; actively involving the learner in the learning process; promoting internal reflection’. The bilateral responsiveness associated with interactive media can help students engage with material at a deeper level particularly so with multi-sensory simulations such as ‘Microsound- The Audio Game’ or Filipczak’s (2017, p. 13-15) ‘caasi’. This format is adept for promoting new novel ways to conceptualise ideas and allows ‘a way to study theoretical concepts abstracted by means of interactive elements’ (Guzman, Dormido and Berenguel, 2010, p. 369). I think I’ve demonstrated the educational benefit of non-linear interactive media by creating a project that I believe would aid novice’s in their understanding of the core idea of ‘sound particles’ something that would be quite difficult to convey in a standard teaching format. Furthermore, elements in the project design such as the preliminary instruction page aid this educational angle.

My second research question was: How can Web-based Audio Games be used to explore new modes for musical expressivity beyond traditional note-based composition and musicianship? Approaching from this angle, one of the main benefits of computing is the functionality to transform datasets extremely quickly through mappings. An example of this is the sonification of particle collision data (Cherston et al. 2016). Also, audio visualisations (*turing code*, 2022). Particularly using large datasets, mappings can introduce a massive amount of complexity into new musical interfaces. This is also achieved, as in my research, by creating simulations with conditions to create complexity.

Computer programming with its line-by-line instruction-based format shares a great synergy with the materialist bottom-up approach to composition described by Filipczak (2017, p. 23). This makes it an optimal format to create systems for this musical approach. Bottom-up musical interfaces are beneficial as they allow users to create complex works without having an extensive musical understanding of the system. This allows users to experience a high level of musical creativity almost immediately unlike traditional instruments, which require a level of proficiency to play with complexity. Web based materialist musical systems such as ‘Microsound – The Audio Game’ therefore increase access to musical creativity, the benefits of which are widely documented (Marlow, 2020). Furthermore, Mishra (2015) explores musical dyslexia and how the conventional written form of music is harder to process for certain people, new interfaces for musical composition will benefit this demographic as musical ideas are conceptualised in different ways.

**Conclusion**

In evaluation of ‘Microsound – The Audio Game’, I’ve succeeded in creating a highly interactive, generative web-based non-linear audio game. Crucially, the project is highly accessible and should be easy to use for first time users, but it also has the potential to create complex tonal compositions. My project presents a novel way to interact with the theoretical ideas presented by Roads (2004). Through the project development, I’ve learnt a lot about creating simulated physics systems and musical interface design through computing. This situates me in a great position for further research. I’m going to expand the project perhaps experimenting with multiplayer applications. Also, I would address some of the clicks and buzzes which despite my efforts can still occasionally anomalously occur. Furthermore, in my more general musical practice I may use data from computed physical simulations to introduce complexity into my electronic music production for instance via mappings on synth parameters. To conclude my will project, allow the opportunity for the non-musically trained to experiment with sound, creating potentially complex generative compositions, and also given that it’s a materialist bottom-up system it should promote experimentation and potentially inspire innovation at different levels of musical structure for example, combinations of sounds, and genre.

**References**

* Albini , G. (2018) ‘Combinatorics, Probability and Choice in Music Composition: Towards an Aesthetics of Composing Systems for Non-Musicians’, Proceedings of the 2018 Bridges Conference, Stockholm, Sweden, 25-29 July. Available at: https://archive.bridgesmathart.org/2018/bridges2018-395.html#gsc.tab=0 (Accessed: 2 May 2023), p. 395.
* Arfib, D. Vaals, V. Xue, K. (2010) ‘TANGIBLE INTERACTION WITH A RYTHMIC SONIFICATION OF THE “GAME OF LIFE” PROCESS’, *Proceedings of ison 2010, 3rd interactive sonification workshop*, Stockholm, Sweden, 7 April. Available at: https://interactive-sonification.org/files/ArfibVaalsXue\_ISon2010.pdf (Accessed: 3 May 2023), p. 109
* *Aura Game* (2015) ‘AURA Trailer’. Available at: https://www.youtube.com/watch?v=7rrfd4CuiVA (Accessed: 2 May 2023).
* Bosch, R. (1999) ‘Integer Programming and Conway’s Game of Life’, *Siam review*, 41(3), pp. 594-604. Available at: http://www.siam.org/journals/sirev/41-3/33825.html (Accessed: 4 May 2023.), pp. 594-596.
* Cairncross, S. Mannion, M. (2010) ‘Interactive Multimedia and Learning: realising the benefits’, *Innovations in education and teaching international*, 38(2), pp. 156-164. doi: 10.1080/14703290110035428, p. 162.
* Carter, B. (1957) ‘A Walkin’ Thing’, *Jazz giant*. Available at: Spotify (Accessed: 11 May 2023).
* Cherston, J. Hill, E. Goldfarb, S. Paradiso, J.A. (2016) ‘Sonification Platform for Interaction with Real-Time Particle Collision Data from the ATLAS Detector’, *Proceedings of the 2016 chi conference extended abstracts on human factors in computing systems (chi ea '16)*, San Jose, USA, 7-12 May. doi:10.1145/2851581.2892295.
* Collins, K. (2008) *Game sound: an introduction to the history, theory, and practice of video game music and sound design*. Cambridge, Massachusetts: MIT Press, p. 4.
* *Dinahmoe* (2011) ‘Plink’. Chrome [Audio Game]. Available at: https://plink.in (Accessed: 12 March 2023).
* *Enviedagir* (2008) ‘BLUE YETI - Magnolya ROY’. Available at: https://www.dailymotion.com/video/x4fg92 (Accessed: 25 April 2023).
* Filipczak’s, D. (2017) ‘Structure & Simulation: Growth and Evolution in Generative Music’, Master’s thesis, Duquesne University, Pittsburgh. Available at: https://dsc.duq.edu/etd/116 (Accessed: 3 May 2023), pp. 11-25.
* Gardner, M. (1970) ‘The fantastic combinations of John Conway's new solitaire game 'life’’ [Mathematical Games]. *Scientific american*, 223(4), pp. 120-123.
* Guzman, J. L., Dormido, S. Berenguel, M. (2013) ‘Interactivity in education: An experience in the automatic control field’, *Computer applications in engineering education*, 21(2), pp. 360-371. doi:10.1002/cae.20480, p. 369.
* Kirnberger, J. (1767) *Der allezeit fertige menuetten- und polonaisencomponist* [Musical score]. Berlin: George Ludewig Winter.
* Lee, B. Jeon, S. (2017) ‘Play or Work?: Generativity in Online Games’ ,*Proceedings of the 2017 Korean Society conference on business venturing and entrepreneurship*, Seoul, Korea, Summer, pp. 37-47 Available at: http://www.koreascience.or.kr/article/CFKO201731960580670.pdf (Accessed: 26 April 2023), p. 42.
* Li, D. (2020) ‘Blob Opera’. Chrome [Audio Game]. Available at: https://artsandculture.google.com/experiment/blob-opera/AAHWrq360NcGbw?hl=en (Accessed: 2 May 2023).
* Marlow, R. (2020) ‘How to Boost Your Kid’s Creativity With Musical Play’, *Parent map*, 20 April. Available at: https://www.parentmap.com/article/how-boost-your-kids-creativity-musical-play (Accessed: 4 May 2023.)
* Matthew, D (2022) ‘Should I Use p5js or Plain JavaScript (HTML Canvas)?’ *David matthew – music, creative coding & generative art*, 8 October. Available at: https://davidmatthew.ie/p5js-vs-html-canvas/#:~:text=Convenience%3A%20It%27s%20easy%20to%20get,otherwise%20be%20trickier%20to%20master (Accessed: 26 April 2023).
* Mishra, J. (2015) ‘How the brain reads music: the evidence for musical dyslexia’, *The conversation*, 8 April. Available at: https://theconversation.com/how-the-brain-reads-music-the-evidence-for-musical-dyslexia-39550 (Accessed: 13 March 2023).
* Roads, C. (2003) ‘The Perception of Microsound and its Musical Implications’, *Annals of the new york academy of sciences*, 999, pp. 272-281. doi:10.1196/annals.1284.038, p. 272.
* Roads, C. (2004) *Microsound*. Cambridge, Massachusetts: The MIT Press, pp. 21-30.
* Roberts, C. Kuchera-Morin, J. (2012) ‘Gibber: live coding audio in the browser’, *Proceedings of the 38th international computer music conference*, Ljubljana, Slovenia, 9-14 September. Available at: https://quod.lib.umich.edu/cgi/p/pod/dod-idx/gibber-live-coding-audio-in-the-browser.pdf?c=icmc;idno=bbp2372.2012.011;format=pdf (Accessed: 13 March 2023), p. 64-65.
* Rocchesso, D. Mannone, M. (2020) ‘A quantum vocal theory of sound’, *Quantum information processing*, 19(9), pp. 1-28. doi:10.1007/s11128-020-02772-9, p. 292.
* Smuts, A. (2009) ‘What Is Interactivity?’, *The journal of aesthetic education*, 43(4), pp. 53-73. doi:10.1353/jae.0.0062, pp. 64-66.
* Sutter, P. (2022) ‘Is all matter made up of both particles and waves?’, *Live science*, 27 December. Available at: https://www.livescience.com/wave-particle-duality# (Accessed: 2 May 2023).
* Trinh, P. Cao, L. (2015) *Aura*. Available at: http://auragame.net (Accessed: 2 May 2023).
* turing code (2022) *Sound visualization - 'irisgram' (spectrogram) p5js*. Available at: https://www.youtube.com/watch?v=8B3GzZo-z9A (Accessed: 4 May 2023).
* Vickery, L. (2011) ‘The Evaluation of Nonlinear Musical Structures’, *Proceedings of the 2009 totally huge new music conference*, Perth, Australia, 30-31 October. Available at: https://ro.ecu.edu.au/ecuworks2011/353 (Accessed: 2 May 2023), p. 74.
* Zenil, H. (2015) ‘Algorithmicity and programmability in natural computing with the Game of Life as in silico case study’, *Journal of experimental & theoretical artificial intelligence*, 27, pp. 109-121. doi:10.1080/0952813X.2014.940686, p. 112.
* Zénouda, H. (2012) ‘New musical organology : the audio-games : The question of "a-musical" interfaces’, *Proceedings of the 2012 International Conference on Multimedia & Network Information Systems*, Wroclaw, Poland, 19-21 September. Available at: https://archivesic.ccsd.cnrs.fr/sic\_01759274 (Accessed: 11 March 2023), pp. 1-5.

**Appendix**

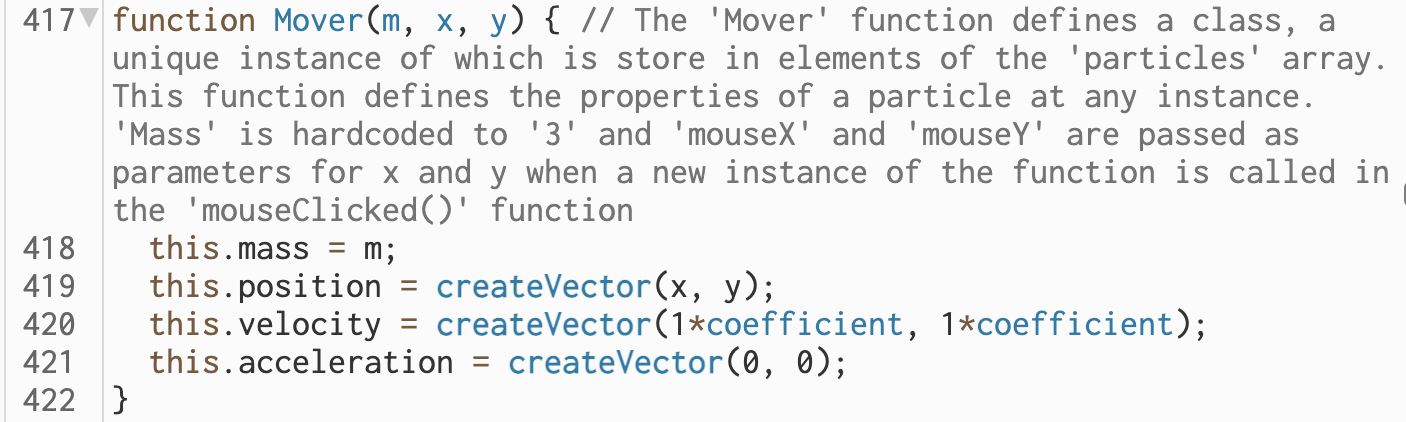
**Figure 1.1**

A picture containing screenshot, design

Description automatically generated

Description: Filipczak’s (2017, p. 14) image showing the interactive generative music piece “Caasi”. This piece of context shares a large degree of aesthetic similarities with my research i.e., the combination of using particles and sound in non-linear media.

**Figure 2.1**

****

Description: Screenshot showing part of the code for ‘Microsound – The Audio Game’. Instances of the function shown ‘Mover’ are used to contains all of the data or attributes for a single particle (position, velocity, acceleration).

**Figure 2.2 - 2.3**

**A screenshot of a computer

Description automatically generated with medium confidence**

A screenshot of a computer code

Description automatically generated with low confidence

Description: ‘Mover.prototype.applyForce’ function, ‘gravity’ variable used as parameter. View comments for information.

**Figure 2.4**

A screenshot of a computer code

Description automatically generated with low confidence

Description: ‘Mover.prototype.update’ function. View comments for information.

**Figure 3.1**

A picture containing text, screenshot, diagram, line

Description automatically generated

Description: Screenshot of flow diagram from my presentation on the project which was cancelled. Shows the breakdown of system logic for a particle. To note since this presentation there were some changes from proposed to actualised system design. For example, in the final version of the audio game there is no user-controlled slider or collision counter causing particles to be destroyed after a certain number of collisions. However, the length of audio particles being recorded is now variable for the user from 10-100 milliseconds.

**Figure 3.2**

A diagram of a particle level

Description automatically generated with low confidence

Description: Screenshot of flow diagram from my presentation on the project which was cancelled. Shows the system logic at an individual particle level. The image shows the initial input parameters associated with a particle. It also shows how ongoing forces continually impact particles.