Nonlinear Time in Electronic Music

Exploring Nonlinear Time in Interactive and Adaptive Electronic Music Composition

Matt Deegan

PhD candidate at University of Gloucestershire, mattdeegan@connect.glos.ac.uk

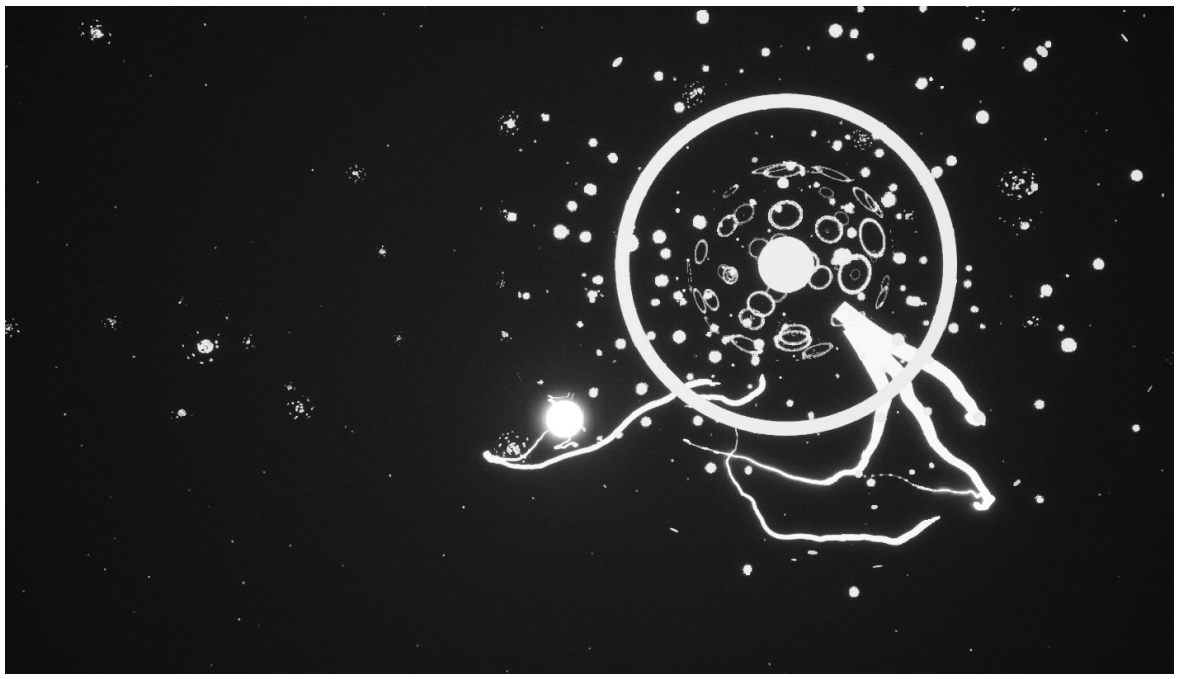

Figure 1 - screenshot from 'The Machines' desktop electronic music application.

Additional Keywords and Phrases: Nonlinear time, Unreal Engine game development software, Acousmatic, Interactive and adaptive

ACM Reference Format for the Audiovisual Symposium:

Matt Deegan. 2022. Nonlinear Time in Electronic Music. Exploring Nonlinear Time in Interactive and Adaptive Electronic Music Composition: In *Audiovisual Symposium Notes '22*, November 25, 2022, Dalarna University, Falun, Sweden.

EXTENDED ABSTRACT

This paper offers an overview of my ongoing PhD research: *Exploring Nonlinear Time in Interactive and Adaptive Electronic Music Composition,* at University of Gloucestershire, UK and covers its technical, practical, and philosophical affordances.

Nonlinearity is established within several different fields, including, but not limited to, mathematics, science, the arts, and philosophy. There are numerous definitions of nonlinearity, and it is often defined by its opposite, linearity. Terms such as, the opposite of a straight line, not in proportion, does not progress smoothly, are used to help describe nonlinearity. It is important to clarify the meaning of nonlinearity for the context of this research, so a musical example is offered below.

Let's say we have a piece of music which starts at A and ends at B; A and B fall on the X axis. The act of playing this piece of music without interruption will result in the music moving along the X axis starting at A and ending at B. However, using game development software[i] as a compositional tool can offer an expanded approach. Spatialization can create the sensation of sound emanating from sources surrounding the listener, as is possible within the real world (Irwin-Schütze, Schütze, 2018). Spatialization is part of the source code in *Unreal Engine* and offers the possibility to move along the X, Y and Z axes. This results in the possibility of composing a piece of music that can start from any position, move in any direction, augment, diminish, reorder, and remix elements of the original composition. This can be achieved through mechanics, player interaction or artificial intelligence.

This Practice as Research PhD employs *Unreal Engine* to compose interactive and adaptive electronic music compositions. The outcome is a portfolio[ii] of music presented as mobile and desktop music applications where players can actively engage with and affect the music output. This paper uses *The Machines*[iii], a single-player interactive desktop application demonstrating techniques in electronic music, sound design and audio programming within *Unreal Engine* 5 game development software; to examine nonlinearity and temporality in interactive and adaptive electronic music composition. *The Machines* is designed primarily as an audio experience; the visual aspects of the application have been carefully considered and are an interpretation of a rhizome[iv], which can connect any points together. These visuals are a nod to philosophical ideas from Deleuze and Guattari's (1987) *A Thousand Plateaus: Capitalism and Schizophrenia.*

The player explores three distinct zones[v], each focused on an aspect of sound design and electronic music composition. There is no obligation for the player to traverse between zones as these were developed to help functionality from a programming aspect, rather than a visual aesthetic or design mechanic. Each zone has no set time limit and there is no set route or objective, other than that of exploring the sound world. Movement between zones is achieved by traversing through a portal, which appears after a randomised percentage of sound interaction boxes[vi] (sintboxes) have been visited.

Although 'game-like', the result is not intended to be a game, there are no objectives, rewards, punishments or intended routes for the player[vii]. Instead, the principle is based on a ludic system[viii] where participants experience the music through play. This ludic system creates temporal structures for "interactive participant[s] within the ludic world" (Lindley, 2004: 183).

The outcomes of *The Machines* are determined by the tools used, which prescribed the sequence of events in the creation process. The zones were created in order, with the visual aspects created after the main functionality and mechanics were completed. Zone 1 – *Machines* focuses on experimental electronic music harnessing MetaSounds, looking at the capabilities of what is currently possible. All 64 modules[ix] of sound are created using MetaSounds, there are no external synthesis or audio files used. Zone 2 – *In Between* focuses on implementation of pre-composed software synthesis. There are 41 single wav files, 22 seconds in length, which are used in combination in UE5 to create 25 randomly spawned chords. The chords are accompanied by randomly

spawned orbiting sounds, which trigger the chords when moving through their path. Zone 3 – *Rhizome* focuses on the implementation of pre-composed contemporary orchestral music, examining the crossover between acoustic and electronic music and the difficulties creating nonlinear adaptive, interactive music whilst employing complex composition techniques. There are sixteen compositions using a combination of orchestral instrumentation; loosely based on contemporary classical music techniques.

Based on work by philosopher S K Langer, Jonathan Kramer (1988) has pinned down definitions of lived/experienced time compared to the perception of time within music. Within Kramer's book, *Time of Music* there is discussion on structure and time stemming from the temporal spaces music creates. He offers a distinction between music starting and stopping versus beginning and ending, rejecting the latter in the most extreme forms of nonlinear music composition. Kramer's ideas have been echoed in recent books including *Being Time* (Glover Gottschalk & Harrison, 2018) and *Music & Time: Psychology, Philosophy, Practice* (Sergeant, Phillips, 2022).

Time of Music was published in 1988, a period when home gaming computers were gaining popularity. There are examples of nonlinearity in music through games created for consoles such as the Commodore 64[x]. In Karen Collins 2006 article *Loops and Bloops. Music of the Commodore 64 Games,* this idea is outlined using microloops, mesoloops and macroloops[xi]. However, Kramer does not discuss computer/video games. The closest he gets to electronic music is a short section *Absolute Time in Electronic Music*, which is focused on tape splicing. Kramer's work was produced at a time when there was a "lack of analytic tools for the study of nonlinear music" (Arauco, 1990: 155). Since then, the advancement of technology has created a tangible opportunity to investigate nonlinear structures in electronic music composition.

Time of Music is somewhat dated and since then a range of research has been conducted within the fields of nonlinearity, temporality, and computer games. The advancement of technology within computer games and game development software is moving at such a pace, there is constant scope to conduct further research into the field. Game development is expanding and set to continue in the foreseeable future[xii]. *UE5*, released in April 2022, is cutting edge and versatile software, which is primed as a platform to explore nonlinearity through built-in spatialisation, virtual and augmented reality pathways, and a fully integrated audio-engine, offering an interesting and exciting topic for research. Furthermore, music composition methods will evolve alongside the technological development and as such, insights and framework(s) will be fundamental in explicating the process.

There is crossover between interactive game audio and nonlinear time, primarily through the requirement for interactive audio to adapt to circumstance within gameplay resulting in a nonlinear approach to music composition. De Landa (2000) considers nonlinear elements in history and philosophy. Authors such as (Kramer, 1996; Kaae, 2008; Paynter, 2015; Glover Gottschalk & Harrison, 2018; Sergeant, Phillips, 2022), offer notable research into nonlinearity and temporality from a multitude of angles. Eugene Holland's (2013) *Deleuze and Guattari's A Thousand Plateaus* discusses the wider relationship between music and nonlinearity comparing jazz improvisation to a rhizome, which in itself has no linear progression.

Deleuze and Guattari's thinking has influenced this work considerably. *A Thousand Plateaus: Capitalism and Schizophrenia* explores philosophical theories through six inter-linked concepts: stratification, assemblages, rhizome, plane of consistency, deterritorialization, and abstract machines (Buchanan et al, 2004). Concepts such as the rhizome fit alongside the practical elements of this project and provide a useful connection that underpins this work. Additional ideas within *A Thousand Plateaus: Capitalism and Schizophrenia*, have inspired the auditory and visual sides of the project; as well as the language used.

The concept of stratification, or more specifically, the articulations within stratification, offer a useful parallel to nonlinear time. Deleuze and Guattari believe "everything takes place in the middle" and one articulation does not lead to the next, rather the two occur at the same time in a relationship of mutual presupposition" (Buchanan, et al, 2004: 7).

Within music, nonlinearity presents a temporal space which always starts in the middle. This can be thought of as 'now' moment. This 'now' is independent from the past or future, has no requirement for beginning or ending and appears 'as a strip of infinite thinness, like a mathematical infinitesimal. A moment in time with no duration?" (Sergeant, Phillips, 2022:12). Buchanan et al. claim Deleuze understands music is nothing, a this-ness, a becoming, much like an event rather than a substance (Buchanan, et al 2004).

The tools provided by *UE5* offer a practical lens to explore nonlinearity in interactive and adaptive music composition. Whilst still in early stages of feedback collection, trends currently suggest perceived playing time is shorter than actual playing time and there is a perceived difference between playing and listening. However, one thing is clear, there is evidence to suggest validity in the continual investigation of this subject matter to develop an ongoing conversation (Glover Gottschalk & Harrison, 2018), with the expectation the investigation will provide further insights and add knowledge to existing research.

ACKNOWLEDGMENTS

Thanks to the University of Gloucestershire, especially my supervisors Prof Abigail Gardner, Dr Matthew Lovett and Dr Philip Reeder. This research was in-part funded by Epic Games through the MegaGrant program (Unreal Engine, 2022).

REFERENCES

Craig A Lindley. (2004) Narrative, Game Play and Alternative Time Structures for Virtual Environments. In Gobel, S. et al. (eds) *Technologies for Interactive Digital Storytelling and Entertainment. TIDSE 2004. Lecture Notes in Computer Science*, vol 3105. Springer, Berlin, Heidelberg. Available at: https://link.springer.com/chapter/10.1007/978-3-540-27797-2_25 [Accessed 7 Oct 2020].

David Butler. (1990) The Time of Music; New Meanings, New Temporalities, New Listening Strategies by Jonathan D. Kramer In *Music Perception: An Interdisciplinary Journal*, Vol. 7, No. 4, pp. 446-450. Available at: https://www.jstor.org/stable/40285480 [Accessed 5 May 2020].

Derek Holzer, Luka Aron. (2022). Laser Phase Synthesis. In *Audiovisual Symposium Notes '22,* November 25, 2022, Dalarna University, Falun, Sweden.

Eugene Holland. (2013) *Deleuze And Guattari's A Thousand Plateaus: A Reader's Guide. London:* Bloomsbury Academic.

Gilles Deleuze, Félix Guattari. (1987) *A Thousand Plateaus: Capitalism and Schizophrenia.* Minnesota: University of Minnesota Press.

Grand View Research. (2022) *Video Game Market Size, Share & Trends Analysis Report By Device (Console, Mobile, Computer), By Type (Online, Offline), By Region (North America, Europe, Asia Pacific, Latin America, MEA), And Segment Forecasts, 2022 – 2030.* Available at: https://www.grandviewresearch.com/industry-analysis/video-game-market [Accessed 21 Oct 2022].

Helen Brown. (1990) The time of music: new meanings, new temporalities, new listening strategies by Jonathan D. Kramer. In: *Fontes Artis Musicae*, Vol. 37, No. 1. Available at: https://www.jstor.org/stable/23507182 [Accessed 5 May 2020].

Ingrid Arauco. (1990) *College Music Symposium*, 30(1), 153-156. Available at: www.jstor.org/stable/40374007 [Accessed 16 May 2020].

Jesper Kaae. (2008) Theoretical Approaches to composing dynamic music for video games. In. Collins, K. ed. *From Pac-Man to Pop Music: Interactive Audio in Games and New Media.* Hampshire: Ashgate Publishing Ltd.

Jonathan Kramer. (1996) *Postmodern Concepts of Time.* Available at: https://scholarworks.iu.edu/dspace/bitstream/handle/2022/3754/KramerPostmodernConceptsV17.pdf?sequence=1&isAllowed=y [Accessed 5 May 2020].

Jonathan Kramer. (1988) *The Time Of Music*. USA: Macmillan.

Karen Collins. (2006) Loops and Bloops. Music of the Commodore 64 Games. In *Journal on Media Culture,* Vol. 8. Available at: https://www.icce.rug.nl/~soundscapes/VOLUME08/Loops_and_bloops.shtml [Accessed 20 Oct 2022].

Karen Collins. (2007) *An Introduction to the Participatory and Non-Linear Aspects of Video Games Audio.* Available at: https://pdfs.semanticscholar.org/b6df/39d9d90f82f25c1ce8a78cdbe52dfbdcdf34.pdf [Accessed 28 May 2020].

Manuel De Landa. (1997) *A Thousand Years of Nonlinear History*. New York: MIT Press.

Michelle Phillips, Matthew Sergeant. 2022. *Music and Time: Psychology, Philosophy, Practice.* The Boydell Press, Suffolk, UK.

Richard Glover, Jennie Gottschalk, Bryn Harrison. (2018) *Being Time: Case Studies in Musical Temporality*. New York: Bloomsbury.

Stephan Schütze, Anna Irwin- Schütze. (2018) *New Realities in Audio. A Practical Guide for VR, AR, MR and 360 Video.* Available at: https://www.amazon.co.uk/New-Realities-Audio-Practical-Guide/dp/1138740829 [Accessed: 17 Oct 2022].

Sung-Shun Weng, Hung-Chia Chen. (2020) Exploring the Role of Deep Learning Technology in the Sustainable Development of the Music Production Industry. In: *Sustainability 2020*, 12(2), 625. Available at: https://doi.org/10.3390/su12020625 [Accessed 12 Jun 2020].

Susanne K Langer. (1953) *Feeling and Form. A Theory of Art.* New York: Charles Scribner's Sons.

Terrence Paynter. (2015) *Form and Process in Morton Feldman's Spring of Chosroes*. *Music Analysis*, 34(1), pp.47-90. Available at: https://doi.org/10.1111/musa.12040 [Accessed 16 May 2020].

Unreal Engine. (2022) *Unreal Engine 5.* Available at: https://www.unrealengine.com/ [Accessed 25 Oct 2022].

Unreal Engine 5. (2022) *MetaSounds: The Next Generation Sound Sources. An overview of MetaSounds in Unreal Engine 5.* Available at: https://docs.unrealengine.com/5.0/en-US/metasounds-the-next-generation-sound-sources-in-unreal-engine/ [Accessed 21 Oct 2022].

[i] Unreal Engine 4 and 5 (Unreal Engine, 2022)
[ii] *The Machines* is one part of the portfolio. There are also pieces examining augmented reality and a piece focusing on adaptability through use of an application programming interface.
[iii] For clarity, the entire project is called *The Machines* and the first zone is *Machines.*
[iv] In post-structuralism philosophy, a rhizome is a nonlinear network capable of connecting any points together.

[v] *Zone* is used in place of *level* due to the association related to the term *level* within computer games. Levels are associated with objectives and an increasing degree of difficulty throughout gameplay, neither of which are appropriate in this case.

[vi] Each sound source has been within the project has been called a *sintbox*, an amalgamation of 'sound interaction box' created for the purpose of this project.

[vii] It could be argued this is a sandbox game, which allows the player creative control and an almost blank canvas to explore. However, sandbox games usually have loose multifaceted objectives, which are created by the player, *The Machines* is a specific audio experience with a single point of focus.

[viii] "Ludic systems are fundamentally time-based and temporal structure[s]" (Lindley, 2004: 183).

[ix] Modules can be likened to iterative loops or patterns. In Form and process in Morton Feldman's Spring of Chosroes, Paynter (2015) discusses connections between these patterns and likens the process to that of asymmetric patterns of Turkish rugs. "Large-scale connections, especially those that involve two or more connective elements, have deeper hierarchical meanings than local connections." (Paynter, 2015: 51).

[x] A console which sold over "thirty million units in its production years from 1982-1993" (Collins, 2006: 1).

[xi] '[A] two-note bassline may provide a (musematic) microloop which repeats twice in a two-bar (discursive) mesoloop, which is then part of a longer eight-bar macroloop.' (Collins, 2006: 4)

[xii] "The global video game market was valued at USD 195.65 billion in 2021 and is expected to expand at a compound annual growth rate (CAGR) of 12.9% from 2022 to 2030" (Grand View Research, 2022).