VOLUME 2: DISSERTATION

The Identification of Production Methods Exploring Cell-based Repetition and Development in Techno Music and Audio-Visual Display.

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Abstract

The Identification of Production Methods Exploring Cell-based Repetition and Development in Techno Music and Audio-Visual Display.

In 2020, accessibility to the tools of electronic music production have become near ubiquitous to anyone with access to modestly powered computing equipment. The use of musical, cell-based repetition as a musical device is straightforward to achieve using these tools, however further production methods are available to augment and enhance this process.

This research investigates production methods exploring cell-based repetition in techno music, whilst exploring the representation of these concepts in visual media to create synchronous audio-visual work.

A practice-based research methodology has led to the creation of this folio of eleven productions of techno music with accompanying audio-visual display. Additionally, this folio is accompanied by a 20,000-word dissertation, exploring the production methods and processes adopted and explored throughout the creative work. The dissertation also contains the compilation of a relevant field of practitioners and audio, that has served as a source of reference for analysis.

Throughout this research, an exploration of temporal time perceptions and plateau-type experiences has served as a guiding aesthetic reference for working with the cellular repetition and exploring methods for creating development over time. In this dissertation, six areas of study are examined: Investigation into suitable construction methods for the creation of repeating cells; the use of polyrhythmic devices; the use of phasing LFO processes to create gradual yet constant, cyclical interactions of timbral variation; improvisation through real-time spontaneous interactive processes and the use of gradual, incremental automation to instrument parameters, exploring non-cyclical, unidirectional change. Lastly, the application of these audio production concepts is explored in the use of repeating visual cells in the creation of the synchronised audio-visual work.

Declaration

This is to certify that

1. The dissertation comprises only my original work towards the degree of Doctor of Philosophy (by creative work and dissertation),
2. Due acknowledgement has been made in the text to other materials used,
3. The dissertation is less than 20,000 words in length, exclusive of tables, maps, bibliographies and appendices.

Signed:

Date: Aug 2020

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It should be noted that while this project takes influence from dance-club culture, the creative work presented isn't implicitly designed for a club-type experience. The audio-visual display is designed for large-scale presentation such as a projection space, but a large monitor or television would suffice. The emphasis of the visual aspect of the project is to provide visual ambience to accompany the audio work. Similarly, the audio is designed to be listened to on a full-spectrum audio system, capable of playing to the full range of human hearing. Particularly important is the representation of bass and sub frequencies within the presented audio. Accordingly, it is not recommended to listen to this creative work audio on laptop speakers or with earbuds.

Introduction

Explorations in cellular repetition, minimalist aesthetic and electronic production are not new to the Western musical tradition. However, in 2020, the ever-present ubiquity and prevalence of portable computing equipment, combined with affordable music software has led to an unprecedented democratisation of electronic music. In 1983, Brian Eno described the recording studio itself as 'an instrument'[1]. At this time, such a practice was only available to a those who enjoyed the financial or academic backing to work in the high-cost environments of professional recording studios. Now only forty years later, this practice is accessible to anyone with a reasonably powered smart phone, laptop or tablet.

When first opening the Digital Audio Workstation or DAW software Ableton Live, the viewer is greeted by 'Session View'. In this mode of the software, a piece of audio can easily be 'dragged and dropped' onto the screen where it will automatically play as repeating loop, ad infinitum. If a second piece of audio is added, the DAW will also play this as a loop, guessing the original tempo of the first loop and synchronising the second loop accordingly. Similar ease of audio looping, although the exact method varies, can be achieved in the DAWs *Garage Band*, *Logic Pro X* and *Pro Tools.* The 'L' in *FL Studio*, another common DAW stands, for 'Loop'. A case could be made that the use of a computer 'studio' to create a loop is the equivalent of learning a four-chord song in G on the guitar[2], playing in C major on the piano[3], or learning *Twinkle-Twinkle Little Star* on the violin[4].

In 2014, my band Blackchords was encouraged by our record label ABC Music to host a remix competition, with the winning entry to be released alongside our new single 'Sleepwalker'[5], the third single to be released from our album 'A Thin Line'. While the sale of this album was not in danger of breaking any chart records, our band had started to receive some world-wide attention due to one of our songs 'Into the Unknown' being prominently featured during an episode of the popular Netflix television show 'Orange Is the New

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[1] Brian Eno, "The Studio as Compositional Tool," in *Audio Culture: Readings in Modern Music*, ed. Daniel Warner (New York: Bloomsbury Academic, 2017), 185.

[2] The guitar chords G, C , D and E minor outline the I, IV, V and VIm of the key of G and are commonly the first chords learnt for students beginning guitar. These chords alone can be used to play hundreds of songs, for example:
Guitarplayerbox, "Choose Songs by Selecting Chords: C, D, Em or G," www.guitarplayerbox.com, accessed February 23, 2020, https://www.guitarplayerbox.com/select/chords/find/songs/?chSel=C&chSel=D&chSel=Em&chSel=G&maxCapo=5.

[3] Piano students learning beginner music in C major are able to play using only the white keys and not the black and if reading music notation, do not have to read sharps or flats in the key signature:
Andrew Scott, Gary Turner, and James Stewart, *Progressive Piano Method for Young Beginners. Book 1* (Hindmarsh, South Australia: Koala Publications, 1999).

[4] Shin'ichi Suzuki's variations on the melody *Twinkle Twinkle Little Star* are the first pieces learnt when studying the Suzuki violin method, a popular method for young violin students:
Shin'ichi Suzuki et al., *Suzuki Violin School. Volume 1, Violin Part.* (United States: Summy-Birchard, Inc, 2018).

[5] Blackchords, *Sleepwalker*, Spotify audio (Australia: ABC Universal, 2014), https://open.spotify.com/track/5RiohXgQhNZtbmtGzYkKFN?si=l-pi52d4QfGv3ttN-jXERA. (accessed Feb 21, 2020)

Black'[6]. In a very humbling response, the remix competition received approximately two-hundred entries from around the world, with the winning entry coming from Irish electronic artist Roza[7]. In an unfortunate twist, what was most striking about the entries as a whole was how disjointed, confused and difficult to listen to so many of the entries were. It appeared that while the means of studio production had quickly become ubiquitous, effective methods of studio production were less so.

This research seeks to take steps to understand conceptual applications to music production working with electronic music comprised of repeating loops, phrases, ostinatos, sequences, fragments, ideas, or as this research will refer to them henceforth; cells. This research does not seek to present as a 'how-to' guide to electronic production generally. Instead, it seeks to explore and analyse my practice as a producer of audio and audio-visual work, investigating the intersection between recursive cellular repetition and linear development over time.

Research Statement

The Identification of Production Methods Exploring Cell-Based Repetition and Development in Techno Music and Audio-Visual Display.

This folio and dissertation present the results of a two-year long, practice-led research project into the following research questions:

1. How can cells be designed to work effectively in repetition while enabling linear development to occur?
2. How can real-time, spontaneous decision making be used effectively as a production technique?
3. How can automation process be designed as a complementary production technique?
4. How can production concepts found within the audio work be represented in visual media to create a synchronous audio-visual work?

Integration of Development with Repetition

Working with repetition does not mean that this research is not interested in exploring development through linear time. However, when working with recursive cellular structures, thought should be given to the creation of these structures themselves. Through the creative work, what cell structures provided the suitable raw materials for the creation of finished productions? Can cell structures be represented other than as cells of audio? Should recursive cells repeat constantly or alternate with other repeating cells? These questions are investigated through Chapter 1. Chapter 2 contains a study of how cells of different lengths can interact with each other to create polyrhythmic effects and larger macro structures from smaller repeating components. Chapter 3 extends the idea of interacting cells of different lengths by investigating assigning phasing low frequency

[6] Netflix, "Orange Is the New Black S02E07," www.netflix.com, June 6, 2014, https://www.netflix.com/watch/70296534?trackId=13752289&tctx=0%2C6%2C5edb0126-eecc-4a0f-b775-2edbf39aeef5-37128646%2C%2C.

[7] Blackchords, *Sleepwalker - Roza Remix*, Soundcloud audio (Australia: ABC Music, 2014), https://soundcloud.com/blackchords/sleepwalker-roza-remix.(accessed Feb 21, 2020)

oscillators to different effect and instrument parameters. Chapter 4 investigates how improvisation and real-time, spontaneous processes can be used within production. Seeking to draw on my jazz and improvisation background, the area of study of my bachelor degree, an investigation into the use of real-time spontaneous performance practices when working with electronic production processes is made.

Chapters 5, like Chapter 3, investigates the other of real-time spontaneity - the creation of autonomous processes, processes that once designed and set into motion, run autonomously from the producer. After all, when working with cell repetition, it is essential to ask, "Why change anything at all?" Working only with the layering of cells across instrument tracks, simply turning cell repetitions on or off without variation to timbre or tone enables plenty of scope for development over time through the addition and subtraction of musical density. Furthermore, if a machine creates exact repetitions of a musical idea, phenomenologically at least, every repetition is different, as the space in time each repetition occupies for the listener is both new and unique.[8]

Chapter 6 seeks to investigate how the production techniques explored in the audio of this folio can be represented in visual media to create a synchronous audio-visual works. What are effective methods to represent the juxtaposition between cyclical repletion and linear development in audio-visual work? What role can autonomous processes play? What elements between the audio and visual should be synchronised and what elements can remain independent?

As well as investigating these discrete research areas, this dissertation seeks to examine effective methods for understanding the interplay between these different production techniques. With machines responsible for generating repetition, as well as creating sound, what value is there in integrating human processes into recordings of techno music? How can human performance and mechanical, autonomous processes integrate in a non-binary way, such that these production techniques can be used in an overlapping, interdependent and symbiotic way.

In an interview with Mark Butler, producer Henrik Schwarz is quoted as saying '… if you play with a laptop, nobody really knows what you're doing there, because it's just a screen. But if you play a sample that everybody knows, and then you start tweaking it, it's quite easy for everybody to follow what's happening.'[9]

While Schwarz talks of variation to cell ideas as a signifier of human performance, this work has sought to use change as a signifier of both integrated human and designed autonomous processes. In this way the introduction and subsequent repetitions of the cell serve as a common framework between the producer and the audience. Throughout the folio, cells are introduced in their simplest and most stripped back form, with minimal use of effects or tonal colouration. In this way, a baseline for the listener is established, which then enables

[8] Anne Danielsen, *Presence and Pleasure : The Funk Grooves of James Brown and Parliament* (Middletown, Conn.: Wesleyan University Press, 2006).
[9] Butler, *Playing with Something,* 56.

the use of development through autonomous processes and performance interactions over time.

During the creation of the short musical cells comprised within the work of this folio, every effort was made to present the listener with a musical concept that was easy to remember and quick to digest. For some, such as philosopher Theodor Adorno, repetition in music represented an infantilising of the audience and likened musical repetition to 'baby talk'[10]. Yet from the outset of this research, a hypothesis has been maintained that working with electronic repetition provides an opportunity to research production methods investigating performance and programming methods, creating development over time in a nuanced and non-infantile way.

Unlike working with performing musicians, working electronically allows for musical cells to repeat exactly and unceasingly, without physical or mental fatigue. When studying the work of relevant techno practitioners, as seen in the subsequent Critical Summary and Analysis of Relevant Literature and Audio, the use of fast and short repetitions such as that of a single bar or less (a bar of music at 124 bpm is less than two seconds) creates opportunities to work in ways that are different to my work as a musician in jazz, rock and classical performance. The use of short and fast repetitions creates an opportunity to make micro-changes and variations with every repetition. Working electronically, these variations are not the same as the micro-fluctuations found in human performance, such as changes to the micro-timing of notes in a repeated guitar riff.[11] In fact, as will be explored in Chapter 1, every effort was made to create maximum 'tightness' and rhythmic consistency between parts through the use of groove templates. Consequently, working in this way presented an opportunity to work entirely with sound design, that is, the sculpting and changing of instrument timbres to create developmental ebb and flow.

[10] Theodor Adorno, "On Popular Music," in *Essays on Music* (USA: University of California Press, 2002), 450–51.

[11] Holger Hennig, "Synchronization in Human Musical Rhythms and Mutually Interacting Complex Systems," *Proceedings of the National Academy of Sciences* 111, no. 36 (August 11, 2014): 12974–79, https://doi.org/10.1073/pnas.1324142111.

Research Methodology

For this research, a practice-led methodology has been adopted to investigate production methods for working with cellular repetition and development in techno music and audio-visual display.

The software and Digital Audio Workstation (DAW) Ableton Live served as the main production tool used for audio creation, in conjunction with the visual software Touch Designer. Additionally, hardware analogue synthesisers including a *Dave Smith Mopho, Dave Smith PolyEvolver* and Korg *MicroKorg* have been used as auxiliaries to Ableton Live. The use of Ableton has allowed for the quick and easy documentation of 'works-in-progress', as the creative works moved towards completion. The recording of 'works-in-progress' in this way has enabled analyses of production methods as they developed over time, with the resulting differences in approach between productions able to be compared through 'A:B' analyses. Review of older DAW projects has enabled insight into how certain hypothesis were tested - which process were ultimately unsuccessful and which proved more useful. In this way, a reflective process of analysis is used in conjunction with iterative processes, in that productions were generated over time through repetitive processes that experimented with both the effect and affect of small changes to the broader production.

As the perfect recall of a DAW-based system allowed for reflective and iterative production processes, so too did the digital compatibility of the analogue hardware synthesisers used, where each synthesiser possessed the ability to save and recall patches and synchronise with a software editor. The use of hardware synthesisers, integrated with a DAW-based system, provided additional playability with further access to hands-on tactile controls; ideal for manipulating and experimenting with timbre during improvisation. A similar interface, although not identical was also created using assignable midi-controllers within the DAW software.

The visual-based software Touch Designer has been chosen to develop and investigate representative production audio-visual concepts due to its ability to integrate with Ableton Live. Inter-app data communication between Ableton and Touch Designer is enabled through the use of custom-built plugins (Ableton) and operators (Touch Designer); created by the Touch Designer software engineers which ship natively with the software.

A compilation and reference to a relevant field of practitioners has proven important for the development of ideas and hypothesis around production. Decisions regarding which productions by what artists to reference evolved as this research has progressed. This process of review included corroboration with critical analyses of techno productions by established music journalists, study of ethnographic-type writing and documentaries about techno as a genre, as well as reviews of electronic and minimalist music production methodology and philosophy. Additionally, as ideas emerged through the production of the creative work, reference productions exploring similar concepts were sought. In this way, auto-ethnographic study derived through the process of the creative work was used to pinpoint relevant practitioners and references. Concepts included the use of cellular repetition whilst exploring linear development, the use of polyrhythmic cells, the use of

improvisation, the creation of autonomous musical processes and the exploration of temporal experiences of time.

While attempts have been made to establish a clear definition of the techno genre, this research recognises that black and white definitions of any genre are fraught. The focus of this research is to investigate cellular repetition and development, a concept common to techno, however research into techno music's relationship with dance and club culture, for instance, falls outside the focus of discussion here. Aesthetic tastes have been used to draw upon the most relevant audio material to reference during this research, some of which falls outside the canon of techno music. Subsequently, the Literature and Audio Review has been through a process of accumulation and refinement throughout this research, as further reading and creative output has dictated increasingly specific areas of reference for this research.

Critical Summary and Analysis of Relevant Literature, Audio and Field of Practitioners

The use of cellular repetition and linear development over time is exhibited in the work of many minimal techno producers, as well as some of the work of New York-based minimalist composers such as Steve Reich. Hence, this research has sought to analyse, extrapolate, as well as draw influence and inspiration from techno as a genre.

Techno first emerged through the 1980s from the city of Detroit, USA as an industrial, minimalist and futuristic post-disco electronic music. It was derived in part from the funk rhythms of 1960s African American rhythm and blues, as well as the electronic timbral explorations of 1970s German synth-bands such as Kraftwerk and Tangerine Dream.[12]. Written on newly affordable electronic musical instruments such as the Roland SH-101 and Yamaha DX7 synthesisers, Roland TR-909 and TR-808 drum machines and the Akai S900 sampler[13] by middle-class African American musicians such as Juan Atkins, Kevin Saunderson and Derrick May, who sought to integrate Europhile contemporary recordings with the funk and groove of African American artists such as James Brown.

The sound of techno found a mainstream global audience in 1989, when it became the soundtrack for both the UK's 'Summer of Love', typified by illegal warehouse and rave parties, as well the fall of the Berlin Wall and German reunification. Though the early 1990s, the sound of minimal techno was established, primarily by Detroit artists Robert Hood and Daniel Bell, who sought to create, as writer Sean Nye describes in his essay Minimal Understandings, "*a basic, stripped down raw sound. Just drums, basslines and funky groove, only what is essential*".[14]

Minimal techno featured longer track durations when compared to many other electronic music genres, commonly between 5-10 minutes. It made only subtle use of differentiated form elements such as breakdowns and choruses. The tempos were slower, compared to Gabba and other techno related genres, usually between 120-130 bpm.[15] Most distinguishingly, it featured use of short, repeating melodic and rhythmic fragments to create cyclical cellular structures, resulting in the restricted use of melodic and harmonic development and instead, preferencing drone and static harmony.

For music journalist Phillip Sherburne, minimal techno production is defined by *"parallel process of reduction and extension: stripping away extraneous ornament, paring down to*

[12] Dan Sicko and Bill Brewster, *Techno Rebels : The Renegades of Electronic Funk*, 2nd ed. (Detroit, Michigan: Wayne State University Press, 2014).
[13] Sicko, *Techno Rebels*, 2014.
[14] John Osselaer, "Spannered | Robert Hood | Music | Features | Artist Interview," www.spannered.org, 2001, http://www.spannered.org/music/802/. (accessed Feb 14, 2020)
[15] Sean Nye, "Minimal Understandings: The Berlin Decade, The Minimal Continuum, and Debates on the Legacy of German Techno," *Journal of Popular Music Studies* 25, no. 2 (June 2013): 154–84, https://doi.org/10.1111/jpms.12032. (accessed April 2, 2019)

only the most salient rhythmic and tonal components, and extending those few elements as far as they can be stretched."[16]

The practice of contemporary techno production has been built on these reductionist concepts. Today, the practice of techno is found in the work of producers based around the world, with a substantial proportion of practitioners basing themselves in Germany and in particular, Berlin. This research has made extensive reference to many contemporary German based artists particularly Wolfgang Voigt aka Mike Inc, Studio 1, Gas; Rene Pawlowitz aka Shed, EQD; Marcel Dettman, Samuli Kemppi as well as North American artists who have relocated to Germany, such as Richie Hawtin, Daniel Bell and Robert Hood. Also relevant are the recording labels Ostgut Ton and Tresor, who's techno releases exemplify the conceptual practice of cellular repetition with linear development in electronic music.

One of the earliest works to be referenced in this research was Manuel Gottsching's E2-E4.[17] Recorded as a minimal, experimental, electronic work in Germany when techno was still in its infancy in the USA, this full-length album features only one track, created in a single improvised take, utilising repeating cellular structures and the addition and subtraction of instrumental track layers to create development. Here, the density of instrumental tracks is responsible for creating development over time, rather than change to existing layers themselves. This work inspired the exploration of single-take, improvised processes as production technique within the creative work.

Research into the understanding of real-time spontaneous and interactive processes exemplified in producer and DJ Jeff Mills' series of performances on a Roland Tr-909 drum machine, on his DVD release *Exhibitionist 2.*[18] This collection of video performances showcases Mills' experiments with timbral development and 'on-the-fly' programming techniques through improvisation. While more of a demonstration of real-time spontaneous interactivity with repeating cells than an integration of this technique into a finished production, Mills exemplifies the energy and spirit that can be generated and encapsulated through the process of improvisation. Moreover, while he does program rhythms on the drum machine, so much of his performance is defined by how he manipulates the tone of the individual drums to create development despite all drum parts repeating as a one bar cell, as well as how much performance can be created through simple cueing and muting.

In a departure from rhythmic and percussive programming, the 1993 production *Enforcement* by Basic Channel, a moniker of German techno pioneer duo Moritz Van Oswald and Mark Ernestus[19] features a single two-bar synthesiser cell which repeats for the entire

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[16] Philip Sherburne, "Draw a Straight Line and Follow It: Minimalism in Contemporary Electronic Dance Music," in *Audio Culture, Revised Edition: Readings in Modern Music*, ed. Christopher Cox and Daniel Warner (New York: Bloomsbury Publishing. Kindle Edition, 2017), 465.

[17] Göttsching, Manuel. *E2-E4*. Youtube audio. Germany: Inteam Gmbh, 1981, https://www.youtube.com/watch?v=Vq-kovIr2BE&feature=emb_log, (accessed Feb 20, 2020)

[18] Jeff Mills, "Jeff Mills Exhibitionist 2 Mix 3," YouTube Video, *YouTube*, January 26, 2017, https://www.youtube.com/watch?v=eU-UsvYbIV0 (accessed Feb 20, 2020)

[19] Basic Channel, *Enforcement*. Spotify audio. Germany: Basic Channel, 1993. https://open.spotify.com/track/2m8N5NDF3OuNXVUAUquszc?si=DfYlnHJPQtSoX5SmmS2YzQ. (accessed Feb 20, 2020)

13:10 duration. Through this production, gradual micro-textural changes are added and explored, creating barely perceptible changes between repetitions yet creating linear development over time. This process served as a central concept to be applied when exploring variation and development repeating cells throughout the creative work, both when applying improvisational processes and designing automated processes.

When investigating music based on repetition, it was important to seek references to understand how much verbatim repetition might be used, as opposed to repetition with slight variation. On the very minimal end of this spectrum is the techno producer Wolfgang Voigt, who also works under the monikers Mike Inc, Gas and Studio 1. It is under the guise as Studio 1 that he released the self-titled album *Studio 1* in 1997.[20]

This album contains ten minimal techno productions, compiled from separate twelve-inch releases. Each production demonstrates the use of short and unchanging repeating cell structures, demonstrating minimal use of track layering to add or subtract rhythmic density. As Brian Eno and Peter Schmidt said on one of their Oblique Strategy cards; "Repetition can be its own form of change."[21] Of Studio 1, music journalist Andy Battaglia writes:

"It's not far into "Neu 1", the first of 10 tracks collected here, when it becomes clear that very little, if anything, is going to change by track's end… But with that realization comes the strange spectral thrill that attends paying attention to nothing beyond what is most fully and firmly in view."[22]

While Voigt uses cellular repetition, the length of the cells do not always divide simply into one another, creating polyrhythmic effects between cells. This is seen particularly on album tracks #1, #5 and #7. Here, 1:1.5 ratio exists between certain percussive cell lengths and the track's ¼ note pulse, articulated by the kick drum, or the 1/8th note pulse, articulated by the kick drum and hi-hat together. Voigt explores this concept further under the moniker Maßstab[23] on the album M:1:5. Here, he experiments with different audio cells exploring 1:1.5 ratios. Voigt describes the use of polyrhythmic effects as the creation of many "interlocking rhythmic orbits which give the music a nice swing."[24] Additional reference to polyrhythm in techno was made to EQD's *Equalized #111*.[25] Further track analysis and how polyrhythmic cells were integrated into the creative work is found in Chapter 2: Polyrhythms.

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[20] Wolfgang Voigt, *Studio 1*, CD (Germany: Profan, 1997).
[21] Brian Eno and Peter Schmidt, *Oblique Strategies : Over One Hundred Worthwhile Dilemmas* (Erscheinungsort Nicht Ermittelbar: Verlag Nicht Ermittelbar, 2001).
[22]Andy Battaglia, "Studio 1: Studio 1," Pitchfork, February 18, 2009, https://pitchfork.com/reviews/albums/12682-studio-1/. (Accessed Feb 12, 2020)
[23] Maßstab, *M:1:5*, Vinyl (Germany: Profan, 1997).
[24] Maria Perevedentseva, "To the Things Themselves: The Strange World Of… Wolfgang Voigt," The Quietus, June 26, 2017, https://thequietus.com/articles/22661-wolfgang-voigt-interview-gas. (accessed Feb 14, 2020)
[25] EQD, *Equalized.* Spotify audio (Germany: Equalized, 2011), https://open.spotify.com/album/28rlnxtFTfN2fnTNZIV9hY?si=ynp0W90EQfqnF104ntOFeQ. (accessed Feb 20, 2020)

Renee Pawlowitz aka Shed's work *Shedding the Past*[26], along with Moritz Van Oswald and Mark Ernestus' aka Basic Channel's *Quadrant Dub*[27] are defining works in techno's use of dub techniques. Here, repeating cells are used in conjunction with dub effects, that is the use of delay and echo effects to create additional rhythmic content to a production. *Quadrant Dub* was one of the first techno records to explore this technique[28], a technique adapted from the dub reggae pioneered through the 1960s by Jamaican artists such as King Tubby and Lee 'Scratch' Perry. *Shedding the Past,* released fourteen years later and named as Resident Advisor's Best Album of 2008[29], employs similar techniques. The use of delays here, in an adaption of traditional Jamaican dub, saw the use of time-synchronized delays, where the echo delay echoes cycle at an exact ratio to that of a production's tempo marking, such as a dotted crotchet or quaver.

The use of timed delay is used extensively throughout the creative work as a production technique that enables cells to be recycled as shorter, fractured echo cells; small, decaying, rhythmic repeats derived from their parent cell. Additionally, experiments with delays through the creative work were used to create polyrhythmic interactions between parent cells and their echoes, through the use of dotted delay values in the delay effect units.

The repetitive use of short musical cells, combined with the maximal extension of tonal, timbral and audio effects, with minor use of aural punctuations such as tempo change or form devices, contributes to the creation of hypnotic, perpetual, plateau-like experiences and a temporal perception of time.

The concept of the plateau and temporal time experiences was a central concept of exploration for New York based classical minimalist composters such Steve Reich, La Monte Young and Phillip Glass. Establishing themselves through the 1960s, much of these composers' work predates the dance-floor orientated productions of techno. However, there are characteristics of classical minimalism that have provided relevant reference for this research. These include the use of a consistent and non-varying rhythmic pulse, the building of large structures through the repetition of small cells and the design of automated musical processes, which once set into motion play autonomously from the performer.[30]

The use of repeating musical cells, common to both classical minimalism and techno, is a process that allows for the exploration of repetition and its effects on the listener.
The experiential plateau, a foundational principle for both minimalist composers and techno producers, was a core aesthetic principle to the generation of the creative work, assessed

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[26] Shed. *Shedding The Past*. Spotify audio. Germany: Ostgut Ton, 2008. https://open.spotify.com/album/4GESV4uUxwWj3RnMXcvJeU?si=w9lLwSWWSc6TmD114OYtqw. (accessed Feb 14, 2020)

[27] Basic Channel, *Quadrant Dub.* Spotify audio. Germany: Basic Channel, 1994, https://open.spotify.com/album/42nhTxeaxPiqdi6VHBz08f?si=ffxMHkRwQ3WQR5y3o5jnRA. (accessed Feb 14, 2020)

[28] Sherburne, *Draw a Straight Line,* 2017

[29] Resident Advisor, "RA Poll: Top 20 Albums of 2008," Resident Advisor, December 17, 2008, https://www.residentadvisor.net/features/998. (accessed Feb 14, 2020)

[30] John Adams. "In Conversation with Jonathan Sheffer" *Perceptible Processes: Minimalism and the Baroque,* ed. Claudia Swan et al. (New York: Eos, 1997), 76.

through reflective and iterative processes to measure the 'effectiveness' of production concepts and their application.

Deleuze and Guattari, in their work of philosophy 'A Thousand Plateaus' define such experiences as *"a continuous, self-vibrating region of intensities whose development avoids any orientation toward a culmination point or external end."*[31] Journalist Simon Reynolds, in his history of dance music 'Energy Flash' describes the '*plateau-states of bliss, awe, uncanny-ness, or prolonged sensations of propulsion, ascension, free fall (and) immersion'*[32] associated with dance music. Wolfgang Voigt when representing the importance of temporal time experiences to his work stated that *"I know I have made a successful track when I have something that is 8 minutes long, but feels like 2 minutes"*[33] while composer Phillip Glass writes *"This music is not characterized by argument and development. It has disposed of traditional concepts that were closely linked to real time, to clock-time."*

As this research continued to examine repetition as a device to enable plateau-type experience, the track *Come Out* by Steve Reich[34] became an important inspiration behind the creative work, although not for its temporal type properties that it was initially researched for. This track, released in 1967, consists of a recording of a single sentence by Daniel Hamm, an African American teenager from Harlem, who was wrongfully arrested and brutalised by police as they tried to extract a confession for murder. This recorded sentence is edited through Reich's four tape machines. As the short loop repeats, the timing of the loop of each phrase is not synchronised, so the tape loops begin to phase with themselves. The sample gradually devolves from a voice recording to something much more discordant over the track's twelve-minute duration. In this way, cellular repetition and development are employed as production techniques, moving from the tangible to the abstract. This technique is an automated process, free from human interaction. Of working in this way, Reich said, "*Though I may have the pleasure of discovering musical processes and composing the musical material to run through them, once the process is set up and loaded it runs by itself."*[35]

The creation of development through automated processes in repeating cells and in particular, phasing between non-synchronised repeating cells, rather than through interactive improvisation is an important research area. More extensive analysis of this production technique and its application to the creative work is explored through the research in both Chapters 4 and 6.

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[31] Gilles Deleuze and Felix Guattari, *A Thousand Plateaus,* trans. Brian Masumi (Minneapolis: University of Minnesota Press, 1987), 22.
[32] Simon Reynolds, *Energy Flash : A Journey through Rave Music and Dance Culture*, 3rd ed. (London: Faber And Faber, 2013).
[33] Telekom Electronic Beats, "Wolfgang Voigt (Slices Feature)," YouTube Video, *YouTube*, April 11, 2012, https://www.youtube.com/watch?v=8xEmq4Giyt0.(accessed June 10, 2018)
[34] Steve Reich, *Come Out*, Spotify audio (Columbia, 1967), https://open.spotify.com/track/6QRWTmPjhKA7pnnKrtxZyl?si=n4rt59scR7Oy7Rm3LTRYyQ. (accessed Feb 21, 2020)

[35] Steve Reich, "Music as a Gradual Process" *Audio Culture, Revised Edition: Readings in Modern Music,* ed. Christopher Cox and Daniel Warner (New York: Bloomsbury Publishing, Kindle Edition, 2017) 431.

Reference Literature

While audio has served as the primary source of reference for research, writings by academics, journalists and artists have enabled this research to better understand the creative processes working to create audio. Mark J Butler's *Playing with Something That Runs*[36] presents research into the creative processes, as well as interviews with many of techno's most critically esteemed artists working in Berlin through the mid to late 2000's, including Pacou, Apperat and Ableton Live software developer and artist Robert Henke. Especially insightful is his research into the role of improvisation in many of these artist's work. This book provides an understanding and analyses of electronic and computer-based music from a context of Western-European music academic analyses. From this book, this research adopted a restricted use of the number of tracks within a production, to simplify performance processes. It also adopted methods for screen-free performance processes during improvisation when working with a laptop

Dan Sicko's book *Techno Rebels*[37] provided insight into the genesis of techno in Detroit, providing further understanding around its early developments and the production methods and conceptual frameworks adopted by its early pioneers. Similarly, Simon Reynolds' *Energy Flash*[38] presents a detailed account around the genesis of electronic dance music more broadly, including its development in North America and spread to the UK, Germany, Italy, the Netherlands and Belgium, to the breakthrough into the mainstream of EDM in the USA in the early 2010's. Minimal techno, the key reference for which this creative work is based, is just one subgenre within a broader dance culture. Study and awareness of this range of dance music has enable this research to narrow its focus, by defining what it is *not*, as well as what it *is*. Interviews with techno artists such Red Bull Music Academy's Couch Wisdom podcast interviews with Richie Hawtin[39], Robert Henke[40], Robert Hood[41] and Modeselektor[42] or composers Philip Glass[43] and Steve Reich[44]; Resident Advisor's podcast interviews with Kevin Saunderson[45]; web documentaries such as the 'Slices' series created

[36] Mark J Butler, *Playing with Something That Runs : Technology, Improvisation, and Composition in DJ and Laptop Performance* (New York, Ny ; Oxford, Uk: Oxford University Press, 2014).
[37] Dan Sicko and Bill Brewster, *Techno Rebels : The Renegades of Electronic Funk*, 2nd ed. (Detroit, Michigan: Wayne State University Press, 2014).
[38] Simon Reynolds, *Energy Flash : A Journey through Rave Music and Dance Culture*, 3rd ed. (London: Faber And Faber, 2013).
[39] Red Bull Music Academy, "Techno Innovator Richie Hawtin," *Couch Wisdom* (podcast), September 24, 2018, https://open.spotify.com/episode/5SvbEqzhKh9Ld32YnUjhsh?si=xKWCB-KpSMyCpOLugpSRUg.
[40] Red Bull Music Academy, "Monolake's Robert Henke," *Couch Wisdom* (podcast), October 15, 2018, https://open.spotify.com/episode/1SxbYuyw0a3dCtViqHOxZa?si=Xfc-nG5HRwCCCy8hZlXpTQ.
[41] Red Bull Music Academy, "Robert Hood: Detroit Techno Giant," *Couch Wisdom* (podcast), May 21, 2018, https://open.spotify.com/episode/228N4spJUyqESYeeNDFch4?si=Eh2BcfuETe2Ek2iUBX8jyg.
[42] Red Bull Music Academy, "Modeselektor," *Modeselektor: Anarchic in Berlin* (podcast), October 1, 2018, https://open.spotify.com/episode/66r1C3vW9J0oIRFPakKVZx?si=_eEsCBk_RXKp-qeeYm3lag.
[43] Red Bull Music Academy, "Definitive American Composer Philip Glass," *Couch Wisdom* (podcast), March 25, 2019, https://open.spotify.com/episode/0tBiRJTXkh2qJsktSvj1Vf?si=zIuO_aWSSEeQKxeO5Gg9fA.
[44] Red Bull Music Academy, "Steve Reich: Pioneering Minimalist Composer," *Couch Wisdom* (blog), April 9, 2018, https://open.spotify.com/episode/3MhQpMvVU5KHvIrE0WEDh9?si=f2md_t3VQPiYH7XQU65iGQ.
[45] Resident Advisor, "R.A.095 Kevin Saunderson" 2008, https://www.residentadvisor.net/podcast-episode.aspx?id=95. Accessed Feb 24 2020

by German YouTube channel Telekom Electronic Beats, featuring interviews with Wolfgang Voigt[46] and Rene Pawlowtiz[47] have served as primary sources from relevant practitioners.

Lastly, Christopher Cox and Daniel Warner's compilation of 69 essays *Audio Culture: Readings in Modern Music*[48] has provided a broad source of conceptual reference and understanding, from Steve Reich's "Music as a Gradual Process"[49], to many of the processes adopted by classical minimalists generally in Kyle Gann's "Thankless Attempts at a Definition of Minimalism"[50], to understanding Brian Eno's principles of using the 'Studio as a Compositional Tool'[51] to Phillip Sherburne's analysis of the commonalities between classical minimalism and techno in "Draw a Straight Line and Follow It: Minimalism in Contemporary Electronic Dance Music"[52]

[46] Telekom Electronic Beats, "WOLFGANG VOIGT (Slices Feature)," YouTube Video, *YouTube*, April 11, 2012, https://www.youtube.com/watch?v=8xEmq4Giyt0. Accessed Feb 2020
[47] Telekom Electronic Beats, "SHED In the Car with EB.TV," YouTube Video, *YouTube*, January 13, 2013, https://www.youtube.com/watch?v=jj2gr0I-OAA. Accessed Feb 2020
[48] Christoph Cox and Daniel Warner, *Audio Culture Readings in Modern Music* (New York Bloomsbury Academic, 2017).
[49] Ibid..(431-432)
[50] Ibid..(419-422)
[51] Ibid..(185-188)
[52] Ibid..(465-475)

Chapter 1

Cell Construction and Repetition

The use of cyclical, recursive cellular structures is an "explicit, foundational structural principle of its (techno's) musical practice", argues Butler in his analytical work 'Playing With Something That Runs'.[53] Much of the music referenced in the Literature Review and Field of Practitioners features cyclical cell structures and experiments with the creation and use of repeating cells is a foundational concept of this research. However, as Butler adds, the use of cyclical, recursive cells does not mean that music built from these structures is not interested in motion or climax.[54] The use of recursive elements does not preclude the existence of form and development over time. This research seeks to investigate the relationship between the cyclical repetition and development over time, with the hypothesis that repetition and variation operate in an interlinked and complementary way.

As investigated in the subsequent chapters of this thesis, cellular structures provide the raw material for development through which variation to timbre and other sonic aspects can be explored. This analysis seeks to determine the critical components of cell construction conducive to both cyclical use and opportunity for development throughout the creative work.

Working with Raw Materials

The most prominent sounds of the folio, providing each production with the most distinguishing features, are the instrument tracks containing melodic cells. Such instrument tracks are sparse within the productions when compared to the number of percussion tracks. Of the seven productions analysed in the Production Breakdown and Analyses Tables seen in Appendix 1, five (*Xylo, Melting, Shadow Boxing, SSTO, Gamelan*) have only one melodic instrument track and two (*Cambodia, RBSO*) have two. In all cases, melody parts are played on synthesisers or as single note samples, re-pitched in a sampler. This approach enables the potential for alterations to be made to each note's amplitude and filter envelope controls - attack, sustain, decay and release. Such manipulations to a melody cell can be seen in Fig. 1.01, which depicts the recorded automation data created through real-time interactions on the melody instrument track *12-Step* in the production *DDL SDA,* where alterations to the cell's wave shape and amplitude envelope are made over time.

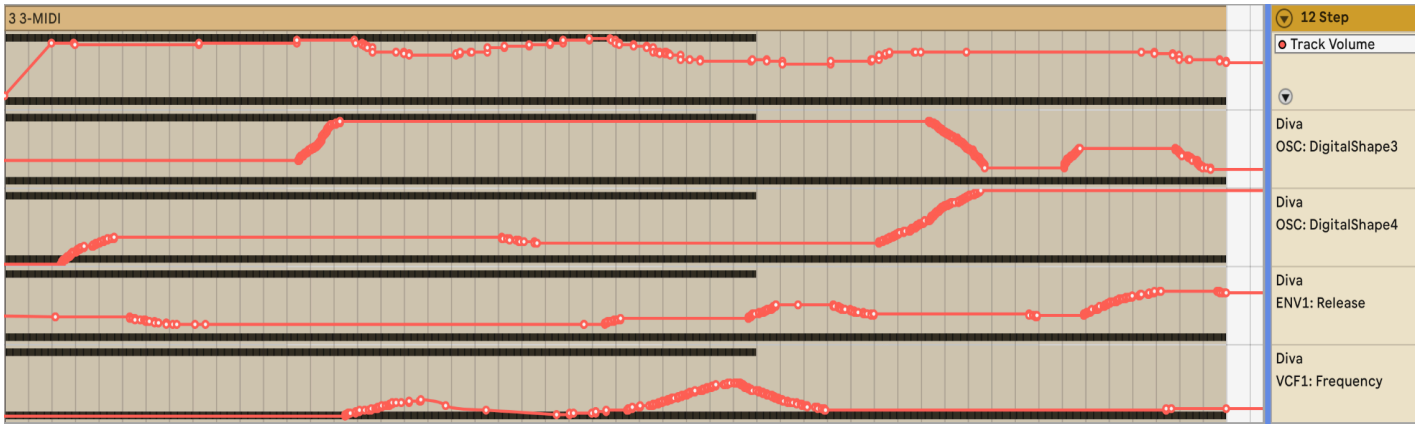

Fig. 1.01 – Automation data of *DDL SDA: 12-Step* from 0:31-7:10 of the production. Alterations to wave shape (OSC:Digital Shape 3,4) and envelope release (Env1:Release), as well as filter frequency (VCF1: Frequency)

[53] Mark J Butler, *Playing with Something That Runs : Technology, Improvisation, and Composition in DJ and Laptop Performance* (New York, Ny ; Oxford, UK: Oxford University Press, 2014). 205.
[54] Ibid., 205

The manipulation and variation to the timbral quality of melody cells in this way, operates in contrast to the use of many of the bass and percussion cells. Instead, these cells, once deployed often repeat without change. The Production Breakdown and Analyses tables in the Track Analyses chapter provide examples of instrument tracks using repeating cells without variation. For instance; in the production *Xylo*, the *Bass, Kick, Pop* and *Breath* instrument tracks contain no observable variations throughout the production (see Table 7 adjacent). Many of the percussion instrument tracks utilise audio loops. For instance, the percussion instrument tracks in *Xylo: Pop, Breath* and *Noise Part* are all comprised of audio loops. However, throughout the folio, all instrument tracks containing melodic cells utilise synthesisers or samplers but never audio loops. Although not a conscious decision at the time of creation, it is possible audio loops were not used as melody cells as this creative work selectively chose to work with the parameters of audio generation found within syntheses and sampling, for the creation of linear development from repeating cells.

Amplitude envelopes were used to create variation in *Xylo: Melody Drone* where the amplitude attack is assigned to an LFO at 0.08 Hz (Fig. 1.02, Table 7, pg16)*, Gamelan: Melody* where the amplitude decay is automated (see Fig. 1.03, Table 11, pg17)*, RBSO: Indie Roll* where the amplitude decay is modulated through real-time interaction (see Table 12, Appendix 1, pg76) and *Melting: Operator* where the oscillator pitch and volume are modulated by different LFOs (Table 9 – see Appendix 1). It should be noted that while there was opportunity to create development through melodic instrumental tracks by the manipulation of synthesis and sampler parameters, in practice, this didn't occur across every production. For instance, extensive use of the manipulation of send volumes to Return Tracks containing audio effects such delay is seen throughout the Production Analysis Tables found in Appendix 1.

Table 7 - *Xylo* - Production Breakdown and Analysis

Track Name	Cell Type	Cell Length	Phasing LFO Processes	Real-Time Spontaneous Parameter Interactions	Incremental Parameter Automation
1. Bass	Bass	1 bar	-	-	-
2. Kick	Percussion	1 bar	-	-	-
3. Hi-Hat	Percussion	1 bar	-	- Send volume to Return Track C to create shaker effect, bar 111-161 (Fig. 3)	- Increase in send volume to Return Track C, bar 41-49, 85-89
4. Dotted Snare	Percussion	2 bars – dotted $^1/_8$ note delay	-	-	-
5. Click	Percussion	1 note every 1, 2 or 4 bars	-	Send to Return Track B, bar 123-145	-
6. Pop	Percussion	1 note every 2 bars	-	-	-
7. Breath	Percussion	2 bars	-	-	-
8. Noise	Percussion	2 bars	- Panning at 0.09 Hz	-	-
9. Melody Drone	Melody	8 bars	- Attack time at 0.08 Hz - Send to Return Track A at a period of 9 bars (17.7 seconds), bar 33-105 (Fig. 2)	Notes recorded in real time	- Send to Return Track C, bar 121-173 - Send to Return Track A, bar 113-181 (Fig. 2)
10. Iso Lunar	Drone	8 bars	- Filter Cut-off 0.07 Hz - Wave Position at 0.04 Hz - Iso Lunar reverb decay time between 2-5 seconds at 0.09 Hz - Iso Lunar reverb wet/dry control at 0.09 Hz - Phaser FX at 0.13 Hz (Fig. 1)	-	- Panning on each note gradually moves from left to right or right to left every 8 bars - Increase in send to Return Track B, bar 113-161
11. Pan Noise	Ambience	1 bar	- Phaser and Panning FX at 0.02	-	- Send volume to Return Track B, bar 139-166,
Return Track A	Long Reverb	n/a	-	-	-
Return Track B	Dotted 1/8th Note Delay	n/a	- Filter modulation at 0.04 Hz	-	-
Return Track C	1/16th Note Delay	n/a	-	-	- Alteration to feedback time at bar 45-53, 85-93
Return Track D	Short Reverb	n/a	-	-	-

Fig. 1.02 - Production Breakdown Analyses of *Xylo*, Table 7 from Appendix 1

Table 11 - *Gamelan* - Production Breakdown and Analysis

Track Name	Cell Type	Cell Length	Phasing LFO Processes	Real-Time Spontaneous Parameter Interactions	Incremental Parameter Automation
1. Mopho P100B1	Drone	Non-repeating	-	- Real time performance utilising filter and feedback parameters on Mopho hardware synth	- Send volume to Return Tracks B, C and D. Envelope copied and pasted for effect to be replicated across 3 different returns, with subtle adjustments. From bar 73-163. (Fig. 16)
2. Bass Sine	Bass	2 beat	-	-	-
3. Kick	Percussion	1 bar	-	-	-
4. Hi Hats	Percussion	1 bar	-	-	- Send volume to Return Track F from bar 121-153
5. Ride	Percussion	1 beat	-	- Ride decay performed from bar 121-155	- Instrument echo increased from bar 101-105, 157 to 161 - Track panning from 105- 109, 161-165
6. 808 Shaker	Percussion	2 beat	-	-	-
7. Glitch Perc	Percussion	1 bar	-	-	-
8. Melody	Melody	2 bars, played in alternating 8ves	-	-	- Instrument decay gradually increasing from bar 17-185 - Send volume to Return Tracks A, B, C and E (through Melody Group track) - Instrument volume increasing from bar 129-153
9. Piano Drone	Drone	8 bars	Filter modulation at 0.53 Hz	-	- Volume fade in and out - Send volume to Return Tracks A, B and C
Return Track A: Filter Stereo Delay A	Filtered Stereo dotted ¼ note (left) and ¼ note (right) delay	n/a	Frequency modulation at 0.04 Hz	-	-
Return Track B: Filter Stereo Delay B	Stereo ¼ note (left) and 1/8th (right) delay	n/a	Frequency modulation at 0.03 Hz	-	-
Return Track C: Filter Spring Reverb	Filtered spring reverb	n/a	Frequency modulation at 0.07 Hz	-	-
Return Track D: Mopho Short Reverb	Short reflections for Mopho track	n/a	-	-	-
Return Track E: Short Reverb	Short reflections	n/a	-	-	-
Return Track F: Hi Hat Delay	1/8th note delay	n/a	Frequency modulation at 0.11 Hz	-	-

Fig. 1.03 - Production Breakdown Analyses of *Gamelan*, Table 11 from Appendix 1

When using delay and echo effects, additional rhythmic information is added to the production. Consequently, this research preferences the use of melody cells using either fewer notes or consistent rhythms. Sparsity enabled delay echoes to be used without cluttering the original cell. Rhythmic consistency, the use of a single subdivision such as a 1/16th note without triplets, enabled the rhythm from the delay echoes to synchronise with the rhythms of the original cell.

On the instrument track *Xylo: Melody Drone,* only two notes in a melody cell eight bars long are used, preferencing sparsity. So too, the melody cell in *Shadow Boxing: Piano* uses a sample of a single minor chord played at three different pitches over a four-bars. *Gamelan: Melody* uses a sample of a gamelan, played at three different pitches over a two-bar cell (Fig. 1.04).

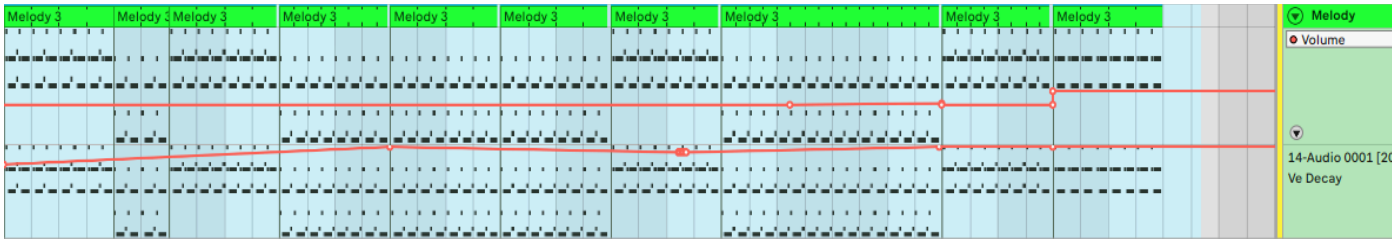

Fig. 1.04 –*Gamelan: Melody* instrument track using a two-bar cell with a sample of a gamelan note played at three different pitches

Alternatively, cells designed using rhythmic consistency include *Cambodia: Kontakt Piano* and *Cambodia: 8ve Piano,* where four pitches over six consecutive 1/8th notes are used in a cell three beats long (Fig 1.05, 1.06), showing rhythmic consistency. *RBSO: Mopho* uses a consistent 1/16th note pulse and *SS2TO* uses a single repeating dotted 1/8th note, a multiple of 3 of the common 1/16th note subdivision. This single rhythmic pulse is additionally reinforced by the same 1/16th note subdivisions found in the delay times of the Return Tracks.

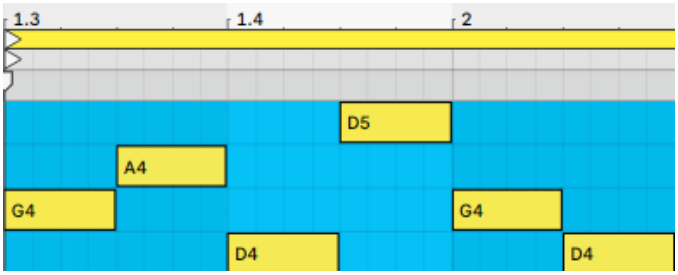

Fig. 1.05 – *Cambodia: Kontakt Piano* cell of 6 repeating quaver notes

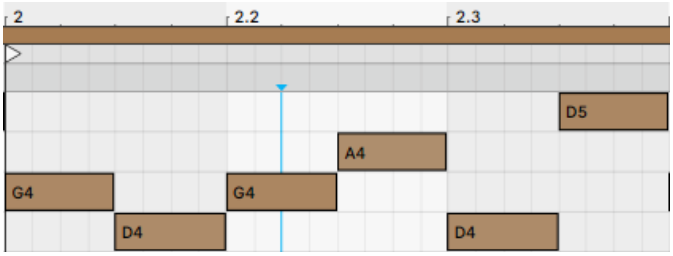

Fig. 1.06 – *Cambodia: 8ve Piano* cell of the same 6 repeating quaver notes, performed an octave higher and starting on the 5th note of Fig. 1.05

Quantisation

Across all analysed productions, the micro-timing of cells was created to conform to a single rhythmic template through the use of Ableton's Groove Templates. This process was used to create synchronised rhythmic timing throughout all of a production's cells. This technique became essential throughout this research to enable a 'works on its own, works as a whole' approach to cell creation, due to the sparse nature of the audio of the creative work, that utilised only 6-12 tracks across a production.

Groove templates allowed for the synchronisation between cells without quantising to the mathematical grid of the DAW, which would often feel overly rigid. In the production *SS2TO*, the groove template SP1200 16-Swing 54 was used, with this template being derived from the timing found within the E-mu SP-1200 sampler, swinging 1/16th notes at 54%. An example of the SP1200 16-Swing 54 template, synchronising rhythms away from the DAW grid is seen here in Fig 1.07 and 1.08.

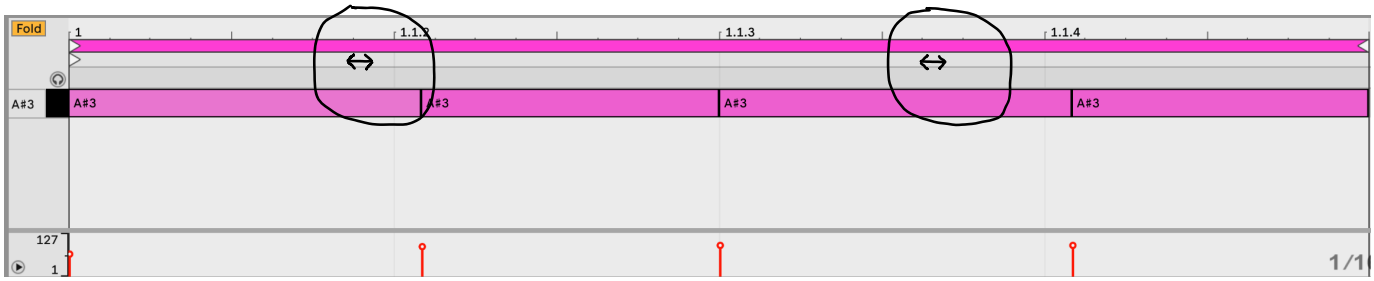

Fig 1.07 – Four 1/16th notes in pink, not aligned to the DAW grid, particularly at the second and fourth 1/16th note, as they are swung at 54%

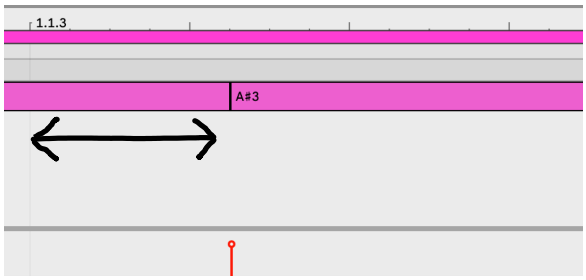

Fig 1.08 – Third semiquaver of the four-semiquaver grouping, at an increased zoom level not aligned to the DAW grid, but not to the same degree as the second and fourth 1/16th notes

Often, trials of different groove templates with varying degrees of swing were made to find a suitable rhythmic groove for the production. Here, the term 'suitable' is used entirely subjectively. For instance, why the 54% swing applied in this instance was be deemed to be more suitable than another value, say 55% is almost impossible to quantify, only to say that a 'goldilocks zone' between a production feeling too rigid (not enough swing) and too jerky or 'skippy' (too much swing) was sought. Quantising became an important production technique for the creation of this folio, principally due to the use of recursive cellular structures and the addition and subtraction of instrumental track layers. The push-and-pull dynamic interplay between instruments of various classic rhythm sections, from jazz to funk and rock, has been studied extensively, such as in Anne Danielsen's Presence and Pleasure: The Funk Grooves of James Brown and Parliament Funkadelic[55]. However, the cellular design of techno music and the use of instrumental track layering techniques require cells to fulfil musical roles both on their own and in any combination within the collective whole. Not only were single subdivisions crucial to the creation of cells, so too was the rhythmic tightness and groove of these subdivisions between parts.

[55] Anne Danielsen, *Presence and Pleasure: The Funk Grooves of James Brown and Parliament* (Middletown, Conn.: Wesleyan University Press, 2006).

Synchronised Volume Envelopes

In addition to the use of groove templates, this research experimented with synchronised volume envelopes to create consistent 'ducking' or 'volume subtracting' effects across tracks, through the use of the audio plugin Tremolator by Soundtoys. The use of ducking is an effect commonly used in EDM and is often referred to as 'sidechain compression', which uses compression to achieve similar results.[56] Experiments through the creation of the folio found that envelopes created within Tremolator were most effective for generating synchronised volume envelopes. Ultimately this concept was employed in multiple ways, including the creation of the rhythm of melody cells in the productions *SS2TO* and *Cambodia (*see Fig. 1.09).

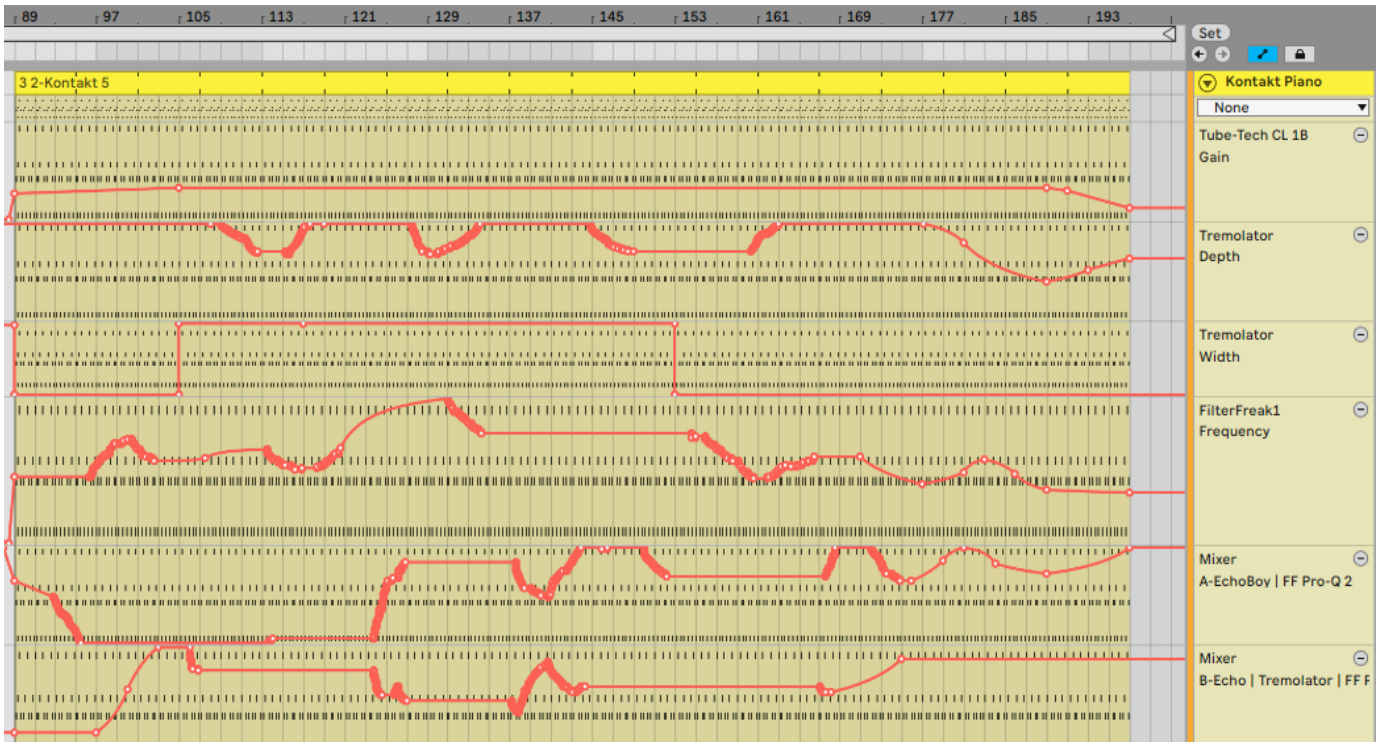

Fig. 1.09 – Tremolator effect applied to *Cambodia: Kontakt Piano*, where Width control was used to create changes between 1/8th and 1/16th notes and Depth control was used to control the decay volume

However, mostly Tremolator volume envelopes were used to create a ducking of volume across multiple instrument tracks either on ¼ note (Fig. 1.08) or ½ note beats, to allow a 'hole' in the audio for the kick drum to play without sonic competition from other instruments.

In the productions *Melting* and *Noobs,* the kick drum plays a ½ note rhythm on beats one and three. A volume envelope was created to generate a sudden reduction in volume across the other instrument tracks on beats one and three, followed by a quick crescendo over two beats towards the next 'duck'. In other 'four-to-the-floor' productions (*Xylo, Cambodia, Shadow Boxing, MJTB, RBSO, DDL STA*, *Gamelans, SS2TO),* the ducking operated on every ¼ note beat. Often, the depth of the effect was adjusted so only minor 'ducking' would occur. In addition to instrument tracks, volume ducking was commonly used on Return Tracks effects. The following is an example of the Tremolator volume envelope effect used on *Return Track C* on the track *SS2TO*.

[56] David Abravanel, "Sidechain Compression: Part 1 - Concepts and History," Ableton.com, March 27, 2018, https://www.ableton.com/en/blog/sidechain-compression-part-1/. (Accessed Feb 14, 2020)

Fig. 1.10 - Volume envelope effect created by Tremolator, used here to generate repeating ¼ note envelopes.

1. Depth – the amount that this effect is being used in a wet/dry capacity, in this instance at a depth of 40%, that is 60% of the dry or unprocessed signal is still present after effect processing
2. Rate – the speed at which the envelope is retriggered. In this instance the speed is synced to the DAW's tempo at 124 bpm, allowing the effect to trigger exactly in time with the other rhythm elements present in the track
3. Shape Editor – this allows the exact shape of the volume envelope to be determined. Here, volume reduction or 'ducking' is created at the beginning of the beat but the volume soon returns, following an inverted exponential curve. As soon the volume curve reaches zero volume reduction toward the end of the beat, it quickly drops to maximum reduction following a curve that prevents any glitching artefacts to the waveform.
4. Rhythm Editor – here the volume envelope cell is repeated at ¼ note intervals operating in 4/4 time.

The use of ducking enabled rhythmic regularity across instrument tracks, even as tonal textures changed throughout the development of the production. The use of synchronised volume envelopes enabled cell design to focus on timbral variation and development, while a regular rhythmic pulse was created by the ducking effects.

Another perspective is that the creation of consistent, repetitive ducking volume envelopes at either ¼ note or ½ note intervals is of itself a repeating cellular design, where an overlaying, repeating effect cell is superimposed onto other repeating audio cells. Here, the recursive volume envelope comes to exist as a repeating cell, while the changes to audio texture operating 'beneath' this effect envelope provide variation and difference. Fig. 1.11 shows the waveform of the percussion audio from *Noobs* prior to a volume envelope being added. Fig. 1.12 shows the same audio with the addition of a 2-beat volume envelope, showing the combined effect of the 2-beat repeating cellular volume envelope combining with the variance of the original audio.

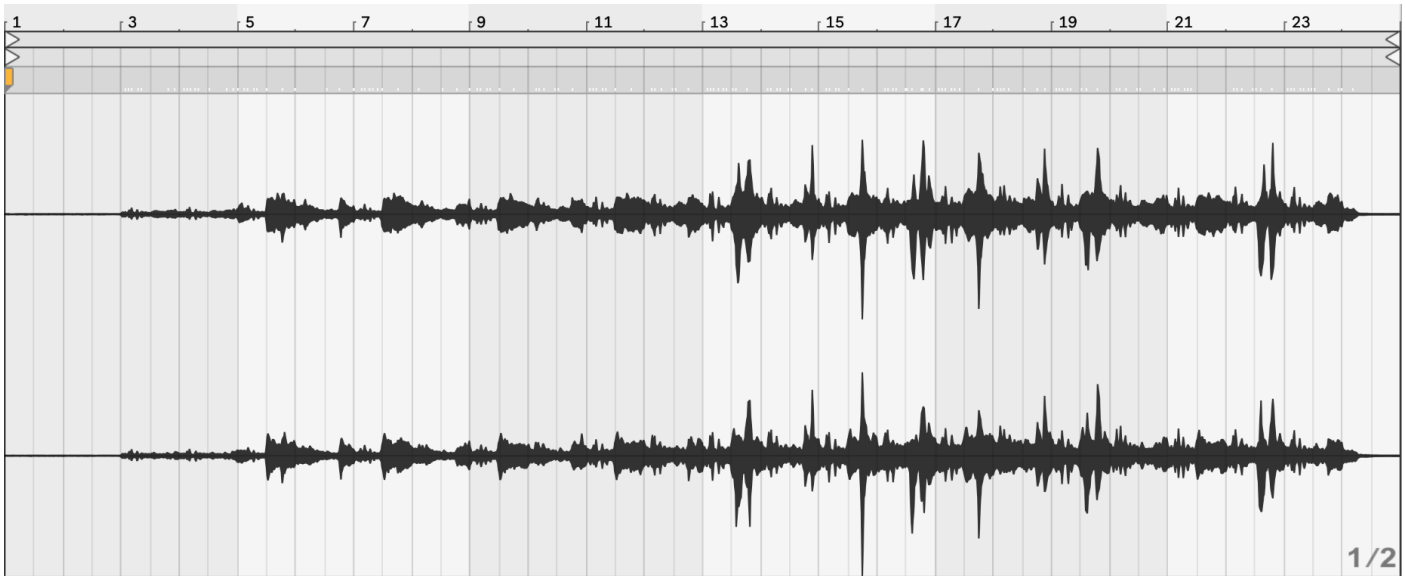

Fig.1.11 – Percussion audio from *Noobs* prior to the addition of a 2-beat volume envelope. In this figure, a 2-beat period is marked by the vertical lines

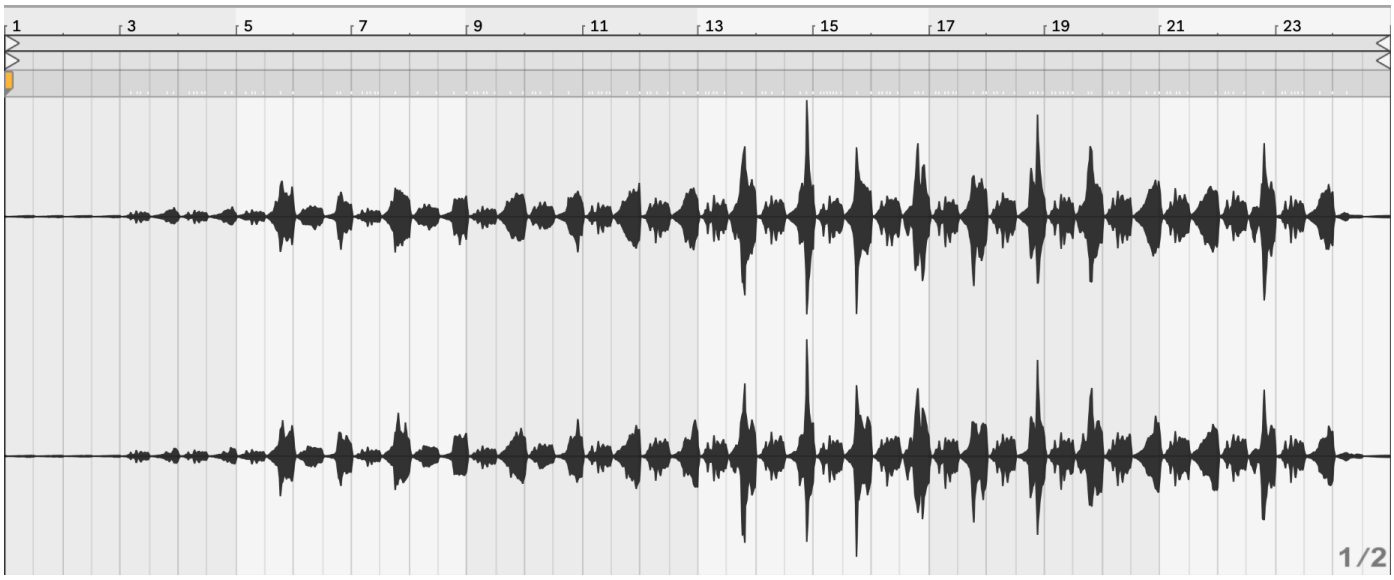

Fig. 1.12 – Percussion audio from *Noobs* with the addition of a 2-beat volume envelope

Single Cells on Instrument Tracks

The use of repeating cellular structures is evident throughout the folio and rarely are different cells used on the same instrument track. Some exceptions do exist throughout the folio, some of which can be seen in the Production Analyses Tables of Appendix 1. For instance, on the instrument track *Xylo: Click* a single click sample plays at intervals of one, two and four bars (See Production Analyses Appendix 1, *Xylo* – Ableton Arrangement). In the instrument track *Gamelan: Melody*, the same melody is played at alternating octaves every eight bars (See Production Analyses Appendix 1, *Gamelan* – Ableton Arrangement). *MJTB* (not analysed in Appendix) contains six notes within a two-bar cell. As the production develops, notes go from being muted to un-muted. *DDL SDA* contains a drone at two different pitches played in an AABA form, where each subsection is 8 bars in length. However, these four examples are the only examples of multiple cells used on a single instrument track throughout the entire seventy-minute folio and are an exception to the rule.

The use of single instrument track cells as a production technique was not readily adopted during the early stages of this research. Revisions of earlier versions of these productions show that different cells were regularly used on individual instrument tracks, creating changes to rhythm and harmony throughout the production. However, through the process of real-time performance, the use of single, instead of multiple cells, became the most prevalent production technique used. In this way, real-time spontaneous performance led to the stripping back and distillation of productions. The use of single cells provides an opportunity to explore development through the use of different production techniques, other than the introduction of new cellular material. It also provides more static content in some instrument tracks to create contrast to the tonal development in other tracks. For instance, the production *Cambodia* contains the percussion tracks *Glitch Loop, Circuit Loop, Click, Click 2* and *Shaker,* which all contain repeating single cells with no change or development throughout the production (Fig. 1.13, see Table 8 – *Cambodia,* pg24). These static cells contrast to the changing textural and timbral sounds in the instrument track *Kontakt Piano* and *8ve Piano* (Fig. 1.09). It was also observed that the use of single cell repetitions was more suited to the creation of temporal time-experiences, rather than moving between a series of cells.

Table 8 - Cambodia - Production Breakdown and Analysis

Track Name	Cell Type	Cell Length	Phasing LFO Processes	Real-Time Spontaneous Parameter Interactions	Incremental Parameter Automation
1. Mopho Audio	Bass	1 bar	-	-	-
2. Kick	Percussion	1 bar	-	-	-
3. Hi Hat	Percussion	1 bar	-	Decay time bar 67-73, bar 151-162	Decay time bar 141-153
4. Ride	Percussion	1 beat – single and doubled part	-	-	Volume on track ¼ note Delay FX bar 68-73, bar 157-161
5. Glitch Loop	Percussion	2 bars	-	-	-
6. Circuit Loop	Percussion	4 bars	-	-	-
7. Click	Percussion	1 bar	-	-	-
8. Click2	Percussion	2 bars	-	-	-
9. Shaker	Percussion	2 bars	-	-	-
10. Kontakt Piano	Melody	3 beats	- Phaser FX applied in Kontakt instrument. Exact speed unable to be determined.	- Note length (Tremolator Depth) - 1/8th note to 16th note transitions (Tremolator Width) - Low Pass Filter Frequency - Send to Return A: Dotted ¼ Note Delay - Send to Return B: Dotted ¼ Note Ping-Pong Delay	- Track volume - Low Pass Filter Frequency - Send to Return A: Dotted ¼ Note Delay - Send to Return B: Dotted ¼ Note Ping-Pong Delay
11. 8ve Piano	Melody	3 beats (same cell as Kontakt Piano displaced by 2 beats, see Fig. 1.05 and 1.06)	- Phaser FX applied in Kontakt instrument. Exact speed unable to be determined.	- Copy and paste of data created in the cell above	- Copy and paste of data created in the cell above
12. MKorg Audio	Pad	8 bars	- Phaser FX applied in the MikroKorg hardware synthesiser. Exact speed unable to be determined.	- Performance using MicroKorg LPF filter frequency	- Track Volume - Depth amount to ¼ note volume ducking applied using Tremolator FX from bar 90-98
Return Track A	Dotted ¼ Note Delay	n/a	-	-	- Delay Feedback at bar 81-85
Return Track B	Dotted ¼ Ping-Pong Delay/Reverb	n/a	-	-	-
Return Track C	Slap Echo	n/a	-	-	-
Return Track D	Short Reverb	n/a	-	-	-

Fig. 1.13 - *Cambodia* - Production Breakdown and Analyses Table from Appendix 1

Pedal Bass Tones

As the research progressed, the use of single-note, pedal tones in the bass parts became a core production technique. Single-note bass parts led to a compositional shift in focus to drone-like production, rather than using the bass to create melodic movement in the lower register, as found in the rhythmically similar 'four-to-the-floor' music of disco and house. Again, this was not a production technique adopted at the outset of this work. The original bass part of the production *Cambodia* contained three different pitches, played across repeating cell four bars in length, before being shortened to its current iteration as a single tone, played across a one-bar repeating cell. This shortening of bass cells was adopted throughout and represented a simplification of these parts. Ultimately, bass parts were designed to be single note two-beat (*SS2TO, Gamelan)* or one-bar (*Xylo, Cambodia, Melting, Shadow Boxing, RBSO)* cells with little modulation throughout the production. The notable exception is *RBSO* which uses polyrhythmic effects and is discussed further in Chapter 2.

The preference for simplified pedal bass cells echoed the research into German-based techno practitioners such as Wolfgang Voigt, Rene Pawlowitz and Marcel Dettman (see Aural Review). Analyses of their work found sparing use of harmonic movement in the use of bass instruments. Working under the moniker EQD, Pawlowitz uses only pedal tones across all ten tracks on his release 'Equalized #111'. Voigt on his 'Studio 1' release features no harmonic movement across any of the ten tracks. Additionally, harmonic simplification in bass cells allowed for long-form process-driven modulation in other instrument tracks through the assigning of non-synchronised LFOs. Further analyses on the implementation of Phasing LFO Processes is contained within Chapter 4.

While the use of repeating cells was adopted at the outset, the nature of implementation and production techniques that arose developed as the research progressed. The creation of melody cells, which formed the most prominent and distinctive elements of production, were designed to be played using synthesisers or samplers. This allowed greater opportunity for the variation of instrument timbre through the use of synthesis and sampler instrument parameters. The use of groove templates to create rhythmic tightness across instrument tracks, yet not strictly aligned to a mathematical grid, proved integral when working with instrumental track layering techniques. Single subdivisions across instrument tracks, such as the use of a single $1/8^{th}$ or $1/16^{th}$ note pulse throughout allowed the use of delay effects in Return Tracks, which rhythmically align with the pre-existing rhythmic material found within different cells. Synchronised volume envelopes were used to create an additional level of repeating cellular structure on top of evolving and changing timbres in instrument tracks. The use of single cells on single instrument tracks created minimal frameworks allowing for more sonic explorations of tone and timbre, rather than variation to pitch, rhythm or harmony, throughout the productions.

Chapter 2

Polyrhythm

Preliminary research into the creative work of established techno practitioners found polyrhythmic devices were used frequently through productions. A polyrhythm is defined as the simultaneous combination of contrasting rhythms[57]. Throughout the techno canon, examples of these contrasting rhythms are created through the use of cyclical cell structures whose lengths do not simply multiply or divide into one another.

Such examples are found throughout in the work of Wolfgang Voigt, especially in his album *Studio 1*[58], as evidenced in the repeating dotted 1/8th note cell of the low tom on track #1 *Green,* the repeating three crotchet bass cell on track #5 *Orange* or the repeating dotted ¼ note 'stab chord' cell on track #7 *Light Blue*. Under the moniker Maßstab, Voigt explored the 1:1.5 ratio at different rates of subdivision through every track on the album *M:I:5*.[59] In Rene Pawlowitz's release *Equalized #111,*[60] track *02*, a repeating cell six beats in length is played against a 4/4 'four-to-the-floor' beat, with backbeat snares on beats two and four.

The ratio of all these rhythms to the overriding 4/4 meter can be reduced to a rate of 1:1.5. In an interview with the Quietus[61], Voigt details his polyrhythmic explorations of this ratio, where the '1' of the 1:1.5 ratio represent either 1/16th, 1/8th, ¼ or ½ notes. The '1.5', therefore exists as cells repeating at length of either a dotted 1/8th, ¼ or ½ notes. In music notation, the use of a dot after a note head means the note is extended by half its value or multiplied by 1.5, hence the terminology 'dotted' note. The almost constant ¼ note kickdrum found throughout both Voigt's and Pawlowitz's work defines the '1' of this ratio, with additional cells created with the ratio of length '1.5' put against it. There is an argument to be made for the description of this polyrhythm as 3:4, as the '1.5' phrase always resolves on the downbeat of the fourth bar. However, Voigt's descriptions of the Maßstab experiments articulate this rhythm as 1:1.5, in reference to the common subdivision, as well as the dotted note. Dotted notes are commonly found as a timing option in bpm-synced delay units, such as the Soundtoy plugin EchoBoy which was used extensively throughout the production of the creative work.

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[57] Merriam-Webster, "Definition of POLYRHYTHM," Merriam-webster.com, 2018, https://www.merriam-webster.com/dictionary/polyrhythm.
[58] Wolfgang Voigt, *Studio 1*, CD (Germany: Profan, 1997).
[59] Maßstab, *M:1:5*, Vinyl (Germany: Profan, 1997).
[60] EQD, *Equalized.* Spotify audio (Germany: Equalized, 2011), https://open.spotify.com/album/28rlnxtFTfN2fnTNZIV9hY?si=ynp0W90EQfqnF104ntOFeQ. (accessed Feb 20, 2020)
[61] Maria Perevedentseva, "To The Things Themselves: The Strange World Of… Wolfgang Voigt," The Quietus, June 26, 2017, https://thequietus.com/articles/22661-wolfgang-voigt-interview-gas. (accessed Feb 20, 2020)

1	Length	1.5	Length
1/16th note	¼ beat	Dotted 1/16th note	(not used)
1/8th note	½ beat	Dotted 1/8th note	¾ beat
¼ note	1 beat	Dotted ¼ note	1½ beat
½ note	2 beats	Dotted ½ note (3 beats)	3 beats
1 bar	4 beats	Six beats	1 ½ bars

Table 2.01 - 1:1.5 Ratio Expressed at Different Rates of Subdivision in 4/4 time

The 1:1.5 ratio was the most common polyrhythm employed in the creation of this folio, being used either as:

- A dotted 1/8th note cell – *SS2TO: 3 1/16ths*
- A dotted ¼ note cell – *Shadow Boxing: Ride*
- A dotted ½ note cell - *Cambodia: Kontakt Piano, 8ve Piano*

(As documented in the Production Analyses Appendix)

Additional 1:1.5 polyrhythms are found in *DDL SOA* and *MJTB*. Fig 2.02 demonstrates how these rhythms re-sync after a given number of beats in 4/4 time, depending on whether the repeating cell is a dotted 1/16th, dotted 1/8th or dotted ¼ note.

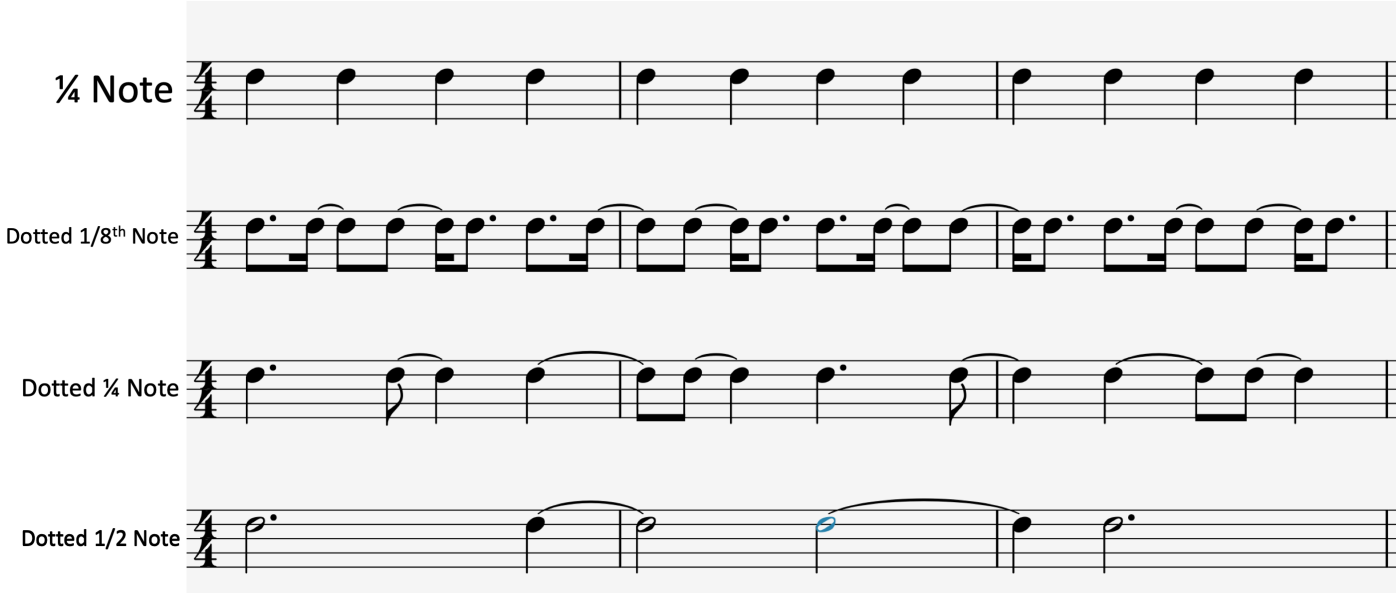

Fig. 2.02 – Shows three different applications of the 1:1.5 rhythm when played in 4/4 time and how the '1.5' rhythm re-syncs with the '1' rhythm on the downbeat of the fourth bar

When a dotted 1/8th note is used, the polyrhythm takes three beats to resolve on a downbeat; in this case, beat four. However, with the creative work preferencing eight-bar phrases, as is widely common feature of the techno productions referenced in this dissertation's Critical Summary and Analysis of Relevant Audio, this rhythm does not resolve at the beginning of an eight-bar phrase for 24 bars. In effect, when these two short rhythmic cells of different lengths are combined, they form a much larger macro-cell, which then also repeats.

In the production *RBSO*, a bass sequence was designed on the Dave Smith hardware synth Mopho and is seen on the instrument track, *Mopho Bass* (see Fig. 2.03). This sequence is one bar long but is punctuated by the opening and closing of a filter, in a sequence five 1/16th notes long (Fig. 2.03, Sequence 3), while being subtly underscored by a drone tone, played by the synth's second oscillator every three 1/16th notes (Fig. 2.03, Sequence 2). This creates a combined a ratio between the three sequences of 16:5:3. The combined polyrhythmic effect of these three sequences is a pattern that requires fifteen bars to repeat

exactly. Against a backdrop of eight-bar phrases this pattern does not repeat again on a downbeat for 120 bars. Additional variation to this instrument track is created through real-time performance interactions, where the audio modulation parameter, filter and release are controlled and altered through performance, discussed further in Chapter 3.

Fig. 2.03 – Three sequences applied polyrhythmically at a ratio of 16:3:5. The highlighted RST on Sequencer 2 and 3 show the point where the sequence is reset.

RBSO also features the instrument track *Reaktor6*, containing a melody cell nine 1/16th notes in length, a ratio of 9:4, with the '4' being articulated by the ¼ note kick drum (there are 4 semiquavers in a crotchet ¼ note). The software Ableton Live enables the looping of cells of any length simultaneously as long as the subdivision – the rhythmic unit that is the largest common denominator, usually the 1/16th note, remains constant. While the 9:4 ratio used by the *Reaktor6* instrument track in *RBSO* is a good example or a more complicated ratio when compared to the 1:1.5 ratio, as the length of time the resultant macro cell takes to repeat is far longer. However, the 1:1.5 ratio yielded the most successful results overall and is the most prevalent polyrhythm found throughout the creative work. It appeared that the repetition of the macro cell was also relevant when implementing polyrhythms.

More complicated ratios were experimented with during the research process, although other than *RBSO*, these experiments did not turn into finished productions to be included in the folio. The use of prime numbers, for instance, when played against each other take far longer to repeat, than the 1:1.5 ratio

rhythms and the mathematical precision of the computer's DAW is ideal for this process. These experiments, for the most part, were too abstract or too complex to be aurally relatable, not conducive to the creation of non-linear time and plateau-like experiences. Yet, the idea of using more complicated polyrhythmic processes as a production tool to create longer non-repeating macros was more successfully achieved through the assigning of multiple LFOs to instrument and effect parameters using non-synchronised time-values. This production process is discussed further in Chapter 4.

The use of polyrhythmic cells was also explored through the audio-visual work, where multiple copies of a single movie cell were overlayed and played simultaneously at different, yet mathematically related speeds. Examples of this method were used in the audio-visual projects created for *Melting* and *Xylo.* This is explored in more detail in Chapter 6.

Chapter 3

Phasing LFO Processes:
Creating Autonomous Processes for Variation in Cell Repetition

Approximately a year into the research, a serendipitous boost was provided through the upgrading of the DAW software Ableton from Version 9 – Standard, to Version 10 – Suite. The updated software came bundled with programming software 'Max for Live', which was not included in Version 9 - Standard, including the plugin 'LFO Tool', which enables any parameter within Ableton Live to be assigned to an LFO. LFO stands for Low-Frequency Oscillator and is a time-variant controller that uses a low-frequency sound wave, generally below human hearing, to create an oscillation to an instrument or effect parameter. Throughout the production of this folio, oscillation lengths were measured in hertz, or cycles per second. As with the use of volume envelopes and time-synchronised delays detailed in Chapter 1, here the use of cellular repetition exists as timed-synchronised oscillations of effect parameter values.

Assignable LFOs are a common feature in many hardware and software synthesisers; however, the synthesisers that this research had access to contained only two LFOs. In contrast, the LFO Tool could be copied across Ableton sessions ad-infinitum, allowing any instrument or effect parameter within the Live set to have programmed oscillations. This was useful if the instrument or effect didn't have any modulation control already, or an additional LFO control was wanted to be added. Furthermore, attention was given to the time-variance rates across all LFO controllers of instruments and effect parameters in a production. Following on from the experiments with higher-order polyrhythm ratios, as well as taking inspiration from the tape work 'processes' of Steve Reich, such as *Come* Out*,* experiments were made assigning multiple LFOs to different parameters across multiple tracks with non-related time-variant controls.

For instance, the instrument track *Xylo: Iso Lunar* contains four LFO modulators (including three LFO Tools and one built into the instrument's phaser effect) controlling five different instrument and effect parameters. An LFO Tool oscillates the filter cut-off at 0.07 Hz, a second LFO Tool oscillates the synthesiser's wave position at 0.04 Hz, a third LFO tool oscillates the reverb decay time between 2-5 seconds at 0.09 Hz, as well as the reverb wet/dry control. A phaser within the instrument operates at 0.13 Hz (Fig. 3.01). The table in Table 3.02 shows the corresponding length of time between the commonly used hertz values of this research.

Fig. 3.01 – Showing the Max for Live plugin LFO Tool, assigned to three of the four moving parameters on the instrument track *Xylo: Iso Lunar*

Hertz	Length in Seconds	No. of Bars at 124 bpm (1 bar = 1.94 seconds)
0.01	100	51.5
0.02	50	25.1
0.03	33.3	17.2
0.04	25	12.9
0.05	20	10.3
0.06	16.6	8.6
0.07	14.3	7.4
0.08	12.5	6.4
0.09	11.11	5.7
0.1	10	5.2

Table 3.02 – Table showing rates of hertz values from 0.01-0.1 Hz, the typical period range for LFOs used throughout the creative work

Due to the non-synchronised relationship between the time-variant controllers, as poly-phasing effect is created between the four different LFO values. In the instance of the instrument *Xylo: Iso Lunar*, these phase interactions create a resultant waveform that would not repeat exactly for 8 hours 28 minutes 44 seconds, if left to play for that length of time. This production technique of autonomous, non-repeating textural and timbral variance (*Xylo* is only 5:54 long) creates an interesting juxtaposition to the short, repeating, single cells which form the building blocks of the presented productions. Whilst timbral variance created through interactive spontaneous processes will be discussed in Chapter 4, experiments with variance created through oscillating autonomous processes allows the creation of larger macro non-repeating structures from small oscillating cells. The perception of this process, when compared to cyclic polyrhythms, is of perpetual flux, change and evolution, rather than resolution to the constant and consistent 'home-feeling' of a downbeat or eight-bar phrase.

In the production *Melting* (see Melting – Production Breakdown and Analyses in the Production Analyses chapter), the assignment of Phasing LFOs to instrument and effect parameters created autonomous processes that operate throughout the production. In *Melting*, these LFO processes were utilised as the prevalent production technique. Operator, the principal instrument generating audio with pitch, uses Ableton's native FM synthesiser Operator. Here, the LFO within the instrument is assigned to all oscillator pitches, although the starting pitches are different to one other, at an oscillation rate of 0.035 Hz . The volume of Oscillator B fades in and out at a rate of 0.06 Hz, the send volume to Return Track C fades in and out at a rate of 0.05 Hz. A filter in the bit distortion effect Bite, which operates as an instrument effect on the track moves at a rate of 0.07 Hz (See Fig. 3.03).

Fig. 3.03 – *Melting: Operator* use of four LFOs (3 LFO Tools and 1 instrument LFO) assigned at 0.035 Hz, 0.05 Hz, 0.06 Hz and 0.07 Hz

The attempt here was to create an autonomous process-driven instrument from which surrounding instruments could be added to generate direction through the production. These additional instruments also contain LFOs, although the variation contained within these instruments is not as acute. This production contains no real-time performance actions other than the deploying and cessation of track cells.

It is worth noting that throughout all productions in the folio, sine waves have all been the preferred waveform used in all LFOs, over triangle, square, saw and noise waves. The gradual and rounded sound produced by sine wave shaped oscillations and their interactions when used to create phasing interactions, subjectively at least, created the most organic sounding timbral variations. With the ability to assign variable oscillation to any parameter within an Ableton set, it was easy to create too much variability, generating a feeling of randomness instead of linear development. Producer and neuroscientist Daniel Levitin in his book 'This is Your Brain On Music' describes the role that expectation plays in our likeability of a given piece of music. Levitin advocates that too much-perceived randomness within a piece of music creates feelings of alienation and disconnection, yet music should possess the ability to surprise the listener as well.[62] Of course, this balance exists on a spectrum and any preference here would be subjective. This concept of balance became a central creative principle, albeit subjective one, to the use of variable timbre applied to repeating cells throughout the work, both through the use of real-time performance techniques and the assigning of instrument and effect parameters to LFOs.

[62] Daniel J Levitin, *This Is Your Brain on Music The Science of a Human Obsession.* (London: Atlantic Books, 2008).

With this balance in mind, experiments with sine waves appeared to be the most effective for creating incremental change. As a listener, the shape of sine waves as LFOs were deemed to be the most predictable and subjectively at least, most aesthetically pleasing to listen to when compared to triangle or sawtooth waves, and especially noise waves. Non-predictable elements were then generated through the interactions of the phasing effects between non-synchronised LFOs. In this way, one process – the use of sine waves – was chosen to create the most expectation, while the other – the use of phasing LFO values – was chosen to create the most variation.

It should be noted that this delineation between the expected and unexpected is wholly subjective, and the ideal rate of variance is subject to the preferences of the listener, which are difficult to quantify, often described as 'taste'. Rates of change and degrees of phasing interactions were calibrated then only to the 'taste' of the researcher, in the hope of connecting the music to other listeners who may share broadly similar musical 'taste'. Additionally, temporal time experiences were a focus, where repetition was used to incite a response of perpetual stasis while variance was used to maintain listener engagement.

Investigation into the Production Breakdown Analyses Tables from the Production Analyses chapter reveals the balance between assigned Phasing LFO Processes and Real-Time Performance Interactions. Both are suitable production methods for the creation of non-repeating variation from cyclical cell structures, however productions such as *Melting* and *Shadow Boxing* made extensive use of Phasing LFO Processes contain few to no Real-Time Performance Interactions other than the deploying and cessation of instrument track cells. As the degree and rate of variation was a factor when creating Phasing LFO Processes, so it appears was the overall amount of variation to be applied throughout an entire production.

Additionally worth noting is that while many of the cells repeat quickly, for instance, a one-bar loop at 124 bpm repeats every 1.9 seconds, the majority of LFO values are assigned between 0.02 Hz – 0.09 Hz which is a repeat once every 11.1 (0.09 Hz) to 50 (0.02 Hz) seconds (See Fig X – Hz Table). When considering the poly-phasing interactions between LFOs, these macro repetitions become significantly longer. It may be true then that short cellular repetitions allow for much longer-term variance and oscillations. Conversely, slow oscillations create change in a gradual way, meaning the deviance between one cell repetition and the next is subtle. It may be true then that when working with minimalist ideas of repetition, integration of gradual over rapid variations is a consideration. When compared to the rate of change typically employed to instrument and effect parameters through real-time interactions, LFO rates were more incremental.

A further note should be given to the tempos of productions within the creative work as listed below in Table 3.04.

Production	BPM
1. Intro	114 bpm
2. Xylo	122 bpm
3. Cambodia	122 bpm
4. Melting	122 bpm
5. Noobs	115 bpm
6. Shadow Boxing	124 bpm
7. Gamelans	124 bpm
8. RBSO	124 bpm
9. MJTB	124 bpm
10. DDL SDA	124 bpm
11. SS2 TO	124 bpm

Table 3.04 – Table of folio productions and BPM

These tempos were chosen, in part arbitrarily and in part to create a work at an almost unified tempo, such that the productions could be mixed together as a DJ would create an unceasing dance mix. Here, the introduction of one piece would be faded over the outro of another. With many of the tempos matching, this would enable the rhythms of the two mixed tracks to play in time with another as this 'cross-over' or 'mix' occurs.

When considering adjustments to LFO rates in the LFO Tool plugin, hertz values rather than bars numbers or time values were used. If tempos were selected to be exactly 120 bpm, very close to the final tempos of these tracks, then many of the LFO values would have intersected exactly with a bar value, as one bar at 120 bpm plays for exactly two seconds. Consequently, an LFO set to 0.05 Hz at 120 bpm would cycle through every 10 bars exactly. The BPM values of the folio productions are close to, but not the same as 120 bpm, meaning that LFOs do not cycle at a rate easily divisible by bar numbers. In this way, more complex phasing processes between LFOs and the prevailing meter of the productions occur.

The concept of utilising LFO Phasing Processes became a central concept of the creation of the audio-visual content in the folio. The use of a single movie sample cell overlayed multiple times is found in all audio-visual productions with the exception of the production *Outro.* As mentioned in Chapter 2, the polyrhythmic idea was adopted for several of the audio-visual projects, however, for the audio-visual projects *Cambodia, Gamelan, RBSO, SS2TO* and *MJTB,* a poly-phasing, process-driven approach was adopted as the central concept. Each of these audio-visual projects consists of either eight copies of a single movie sample cell, or four copies of two different movie sample cells, all playing at slightly different speeds. In the audio-visual project *Cambodia,* two slow-motion videos of the same break-dancer are looped simultaneously at 100%, 99%, 98% and 97% of the original movie speed. As the project progresses, the movements of the dancer gradually drift apart, and multiple versions of the dancer are represented simultaneously.

Chapter 4

Improvisation: Integration of Real-time Spontaneous Performance Interaction

Improvisation

Despite coming from an improvisation background, finding a precise definition of improvisation proved difficult. Personally, improvisation evokes ideas around spontaneity and intuition. The researcher Nicholas Cook, who studied the concept of improvisation across different cultures, believes the concept of improvisation is distinct to music informed by Western European musical traditions, as being separate from composition[63]. Despite attempts at viewing improvisation through alternative paradigms, through the creative work composition and improvisation were applied to production as different processes

In the 'Semiotics of Improvisation', writer Keith Sawyer argues that the critical aspect of improvisation is its contingent quality, in that while the products of improvisation have structure, they are only viewable after the fact[64]. Central to this definition is the idea that the structures of improvisation emerge only through a process of performance and are not predetermined. Therefore, improvisation implies a real-time process, where spontaneous and responsive processes occur through linear performance.

Ultimately, through the creative work, improvisation was used as a real-time process that enabled structures, principally form, to emerge through a process of performance. Once created, many of these structures were used verbatim and included in the folio, unaltered from the original take. Some performances, however, were edited, with changes to specific instrument tracks while others were maintained. Through the creation of the folio, it has been curious to reflect on much of the production process occurs outside of the real-time performance process. During the process of production, it was easy to end up working through never-ending 'to-do' lists of parameter tweaks and micro edits. As a counter, improvisation has been usefully employed as a means to reduce reliance on the endless corrective aspect of production that technology enables. This corrective process enables endless opportunity to edit and get music 'right' but in doing so, as producer Rick Rubin once described, this process can easily rob the music of its 'human drama'[65].

The first pieces written for this folio focussed almost entirely on improvisation as a process. The method was to take a collection of cells, written across a handful of instrument tracks and turn them into finished productions; to take cells operating as cyclical loops to create music with linear narrative unfolding through a beginning, middle and end. The cells were written prior to improvisation in a process much closer to composition, as too was the majority of the sound design. Once cells were designed to suitably complement each another (see Ch. 1), a process of improvisation was undertaken, where cells were either turned on or off, and designated synth

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[63] Nicholas Cook, "Making Music Together, or Improvisation and Its Others," *Jazz Research Journal* 1, no. 1 (March 1, 2004), https://doi.org/10.1558/source.v1i1.5. 5-25. (Accessed Feb 12, 2020)

[64] R. Keith Sawyer, "The Semiotics of Improvisation: The Pragmatics of Musical and Verbal Performance," *Semiotica* 108, no. 3–4 (1996), https://doi.org/10.1515/semi.1996.108.3-4.269. (Accessed Feb 14, 2020) 269-306.

[65] Andrew Romano, "Rick Rubin on Crashing Kanye's Album in 15 Days," Newsweek, June 27, 2013, https://www.newsweek.com/2013/06/26/rick-rubin-crashing-kanyes-album-15-days-237646.html. (Accessed Feb 12, 2020)

parameters were experimented with, creating development to the track as the cells repeated. This process is best exemplified in the production *DDL SDA*.

Improvisations were complete performances, going from beginning to end, not dissimilar to how a jazz group might record in the studio. Takes were made until a performance was captured that, at least subjectively, encapsulated the right 'energy'. If particular cells were lacking the right groove, right density, or if the sound design could be improved, cells were re-composed, and the process of improvisation would begin again. Improvisation then came to form one step of a three-step cyclical creative process (see fig 4.01)

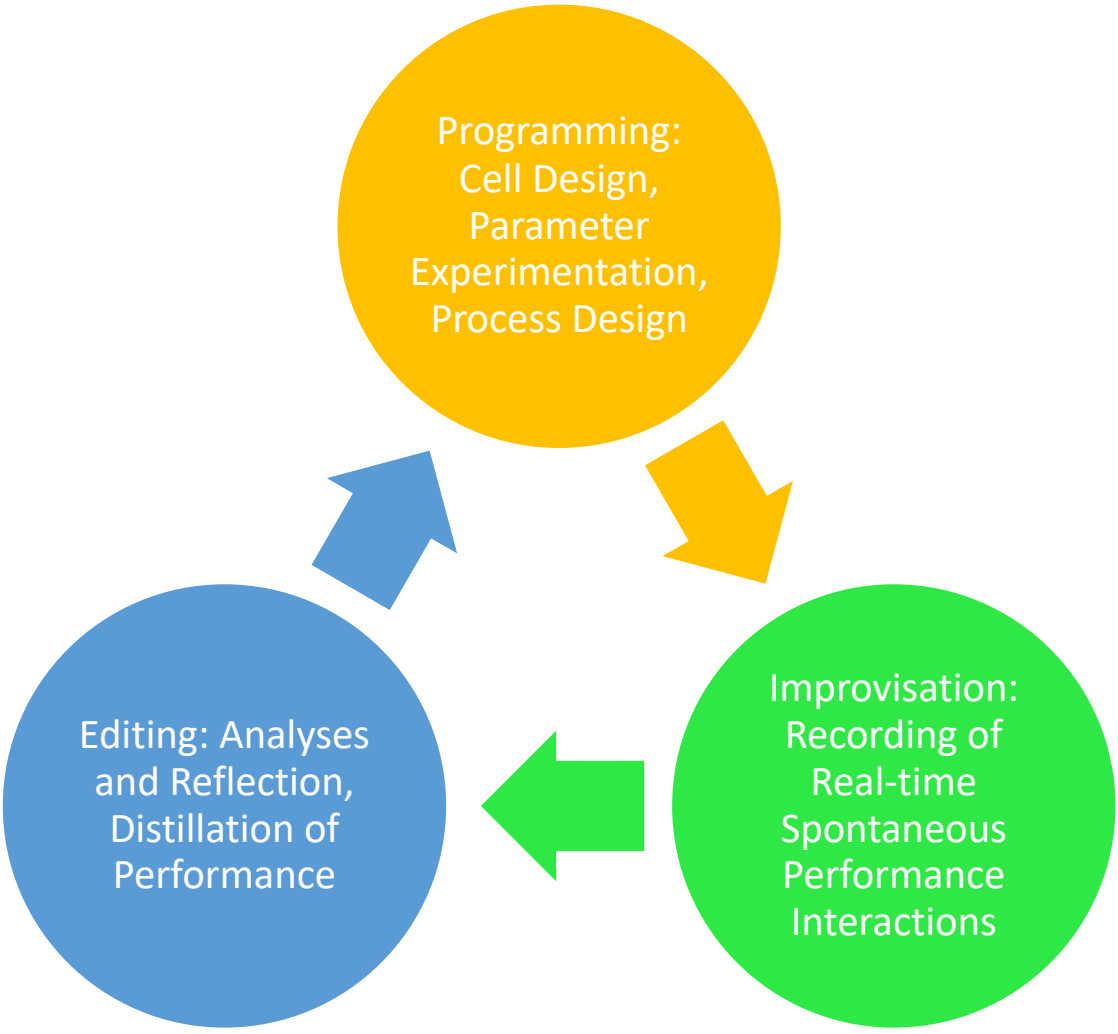

Fig. 4.01 – Representation of production procedure where improvisation, where improvisation is one of four steps. Additional detail regarding the roll of the other steps here is detailed at the end of Chapter 5.

Apart from the use of instrumental track layering processes, Real-time Spontaneous Interactions sought to develop and explore textures across a range of cells, however the focus for applying the most development was to the instrument tracks containing cells with melodic content. The data created through these real-time interactions can be seen here (Fig 4.02) for the instrument track *Shadow Boxing: Piano.* Here, the cell itself remained unaltered but send volumes to four different Return Tracks containing a long reverb, a ¼ note filtered delay, a ¼ note ping-pong delay and an 1/8th note reverse delay are manipulated and altered through a process of real-time spontaneity.

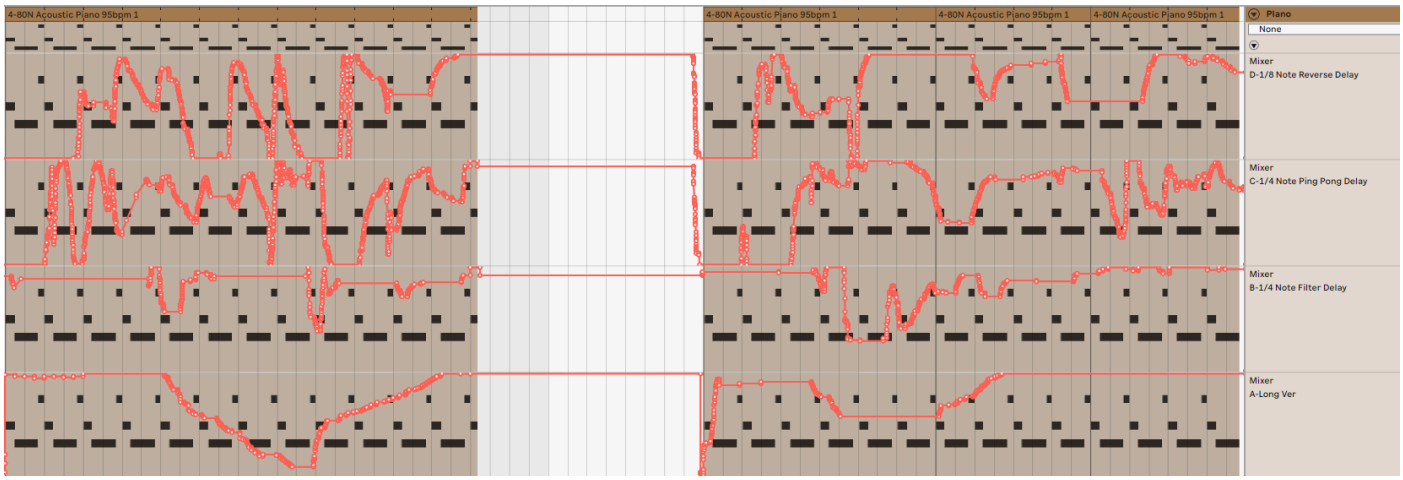

Fig. 4.02 – Automation data recorded from real-time spontaneous interactions on the instrument track *Shadow Boxing: Piano* from 1:45-5:50.

A similar approach was adopted on the instrument track *Cambodia: Kontakt Piano* (Fig. 1.07, Chapter 1) where changes were made to Tremolator Width and Depth, Filter Frequency, send volume to a dotted ¼ note delay and send volume to a dotted ¼ not ping-pong delay.

Melody cells were not the only cells utilised for real-time performance interactions. In the instrument track *Xylo: HiHat*, the cell is sent to a 1/16th note delay from 3:30-5:15 (Fig. 4.03) to create a rhythmic shaker type effect that gradually increases and fluctuates in volume as the production builds.

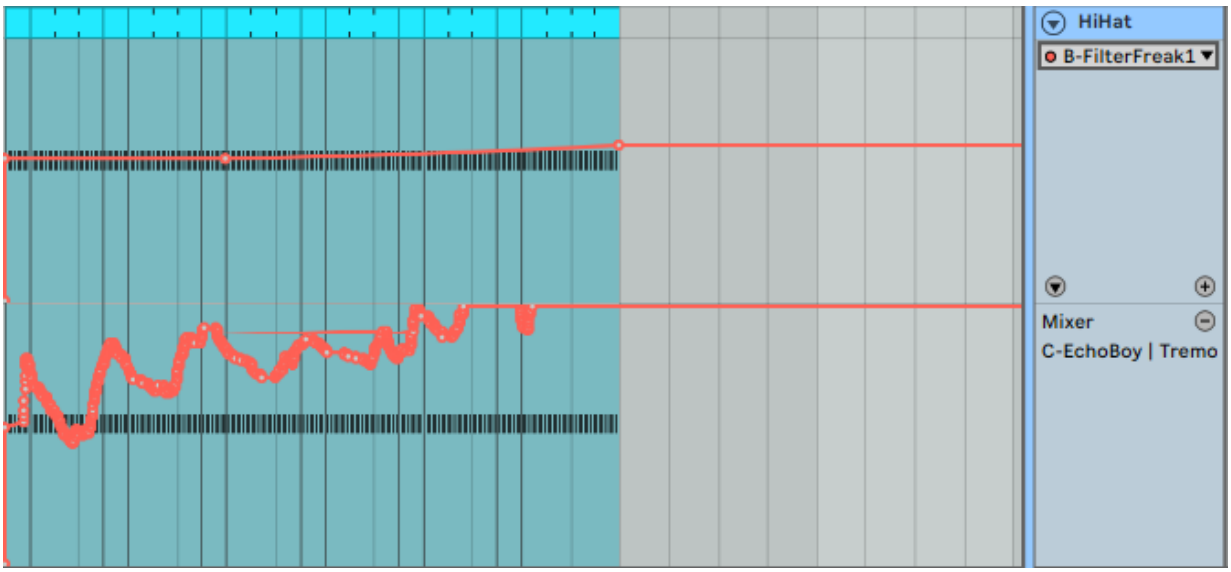

Fig. 4.03 – *Xylo: HiHat* send to 1/16th note delay, created through real-time performance interactions, while incremental parameter automation was assigned to a dotted 1/8th note dela

The approach, whilst satisfactory enough, applied a compartmentalised method, using a passive computer and an active producer in performance. With improvisation came the challenge of having suitable control over enough parts to generate spontaneous variation and development, without being overwhelmed by controller options or challenges to dexterity. This meant there were further questions as to how instruments could be better designed to play cells autonomously in a way that created the organic and sometimes serendipitous results achieved through spontaneous performance. Additionally, it was believed that there was an over-emphasis on spontaneity for spontaneity's sake. If satisfactory results could be obtained through other means, they too should be explored and integrated.

During the completion of the folio, I was invited to perform laptop with the Melbourne Symphony Orchestra for the debut of *"Forever Turning Winter Into Spring",* a work composed by Adrian Vincent and Lior Attar, as part of the orchestra's 2019 Metropolis series. Triggering samples from a laptop as well as making controller adjustments, my part was entirely scored and needed to be performed with precision. Performing electronically with an acoustic orchestra was a fantastic, if not somewhat daunting experience, not in the least part due to the orchestra's broad interpretation of the conductor's beat.

The composition was straightforward for the most part but did contain some passages requiring dexterous moves with the MIDI controller, which took many hours of practice to perform with the reliable precision.

In the creation of this folio, I wanted to avoid performances overly reliant on muscle memory and exercises in dexterity. The problem with this approach was that it no longer felt like improvisation and the productions could not reveal themselves in performance. Perhaps with more perseverance, a less self-conscious and clumsy technique could have emerged where multiple parameters could be manipulated and controlled in a way that felt both satisfactory and spontaneous. Through my undergraduate years, I spent many hours practising scales in such a way that my spontaneous jazz improvisations could be both dexterous and intuitive. However, ideas began to emerge regarding how the computer may be more fully utilised to create an organic and interactive 'other' that would exist as an auxiliary to real-time performance interactions. Elements of improvisation could be retained in the final production, but spontaneous performance didn't have to be the central focus of the work.

During the creation of the production *RBSO*, performance interactions, performed on a Dave Smith Mopho hardware synth were combined with polyrhythmic elements created in the instrument's three step sequencers. These three sequences were all of different lengths, existing in a ratio of 16:5:3 (discussed in Chapter 2). Here, real-time spontaneous performance processes were combined with programmed mechanical polyrhythmic elements on a single instrument track. These performance interactions controlling the instrument's audio modulation, filter and amplitude release can be seen here in Fig. 3.04, where the MIDI CC controller data was recorded. Here; A shows the changes to audio modulation control, B shows the opening and close of the envelope filter and C is the amplitude releas

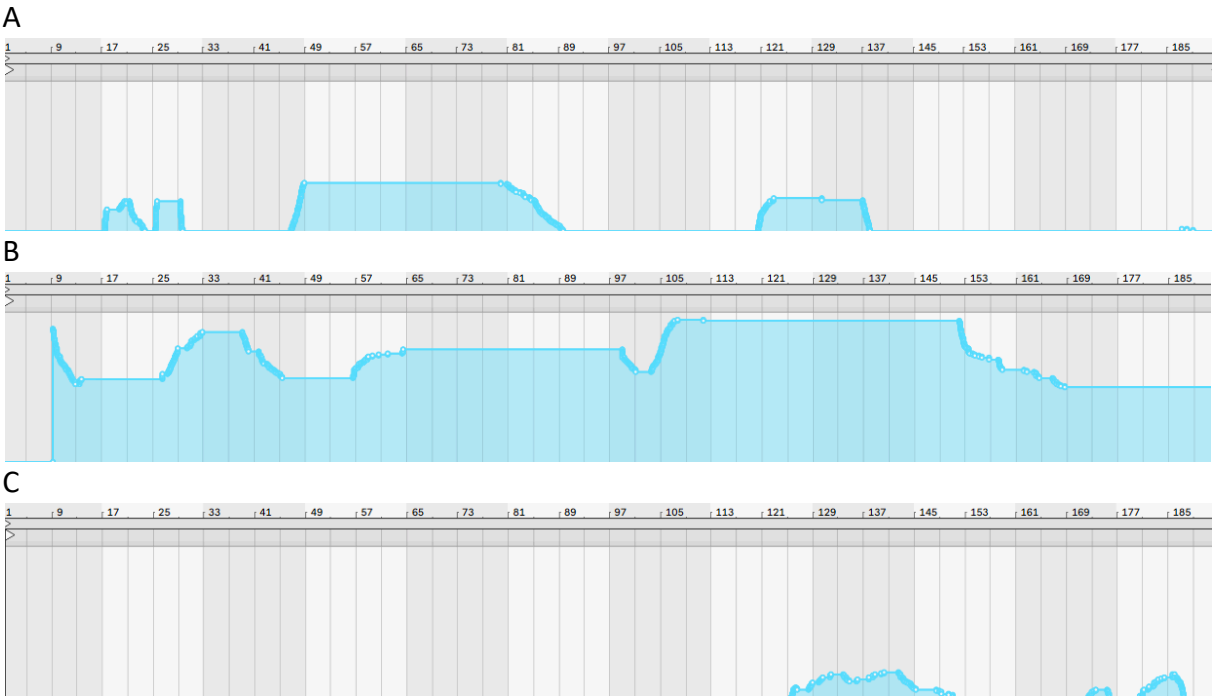

Fig. 4.04 – CC controller data recorded from a Dave Smith Mopho synthesiser on the instrument track *RBSO: Mopho*

The combining of performative elements with higher order polyrhythmic processes was the beginning of a more integrated method of production where real-time interactions interacted with programmed processes, representing a shift away from the binary passive/active methods adopted at the outset of the research. This led to the exploration of other techniques, such as the use of Phasing LFO Processes, discussed in Chapter 3 and the Incremental Automation of Parameters discussed in Chapter 5.

As these additional methods became increasingly integrated into productions, improvisation and spontaneous performance was still maintained as the principal method of generating form from cyclical cells. When working with repeating cells for extended periods of time, it was often difficult to imagine what it would be like to listen to a given cell for the first time. As listening is a process that occurs in real-time, it made sense, at least intuitively, that the most effective way to compose form is through a real-time process, such as performance, rather than through the editing process, which exists outside of this time frame. While other methods of form creation were experimented with, such as the 'dragging and dropping' of cells around the production arrangement, or parallel copies of form from reference productions, such as those included in the Critical Summary and Analysis, the results felt underwhelming, and lacking in flow. The hypothesis of the use of spontaneity as an effective method to create form from repeating cells held true throughout the production of the creative work.

Outside the creation of form, the integration of improvisation through the productions of this folio ranges in scope. As mentioned previously, the first production completed for this folio *DDL SDA* made extensive use of improvisation as a production method and similar processes were applied during the production of *Cambodia* and *Gamelan.* For other productions, this spontaneous performance was far less performative and resembled more

of a contemplative cueing process, playing and stopping pre-designed cells containing detailed autonomous LFO Process information. This technique was used to create *Xylophone, Melting* and *Noobs.* Other pieces such *as RBSO, Shadow Boxing, SS2TO, MJTB* and *Outro* integrated real-time interactivity along with the cueing of pre-designed autonomous LFO Processes in more equal measure.

The Ableton arrangement view of seven productions have been provided in the Production Analyses Chapter. These arrangements display how cells were used additively to create development over time, exhibiting the final form constructed from repeating cells, produced through the improvisatory methods of real-time spontaneous decision making.

Chapter 5

Incremental Parameter Automation: Programming Gradual, Non-Cyclical Change to Repeating Cells

As gradual and incremental change was implemented through the use of Phasing LFOs, the use of non-cyclical variations through the use of automation developed as a counterpart. In contrast to LFO assignments to parameter values, which are a form of cellular repetition, experiments were made using extended, gradual and unidirectional parameter changes.

The use of automation to control instrument and effect parameters is a common feature of many DAWs, with multiple uses across different projects. For instance, volume automation, can be used to 'ride the fader' and create volume adjustments to smooth sudden unwanted changes in a performance. The use of automation in this way was used during the mixing of the creative work, to reign in some of the more unruly sounds generated during improvisation, such as on *RBSO: Mopho* and *DDL SDA : 12 Step*. However, the use of automation in this way is not the focus of the creative process here.

Whilst the use of short repeating cells was used throughout the creative work, there was an exploration of development by moving from simplicity to complexity. instrumental track layering techniques, along with the use of real-time interactions with instrument and effect parameters increased and decreased musical density as the productions progressed. An analysis of the Ableton arrangement views provided in Production Analyses Appendix 1, shows cell density alone to be far greater in the second half of productions than the first half, with the greatest density peaking at around 80%, on average. The use of extended incremental automation to instrument and effect parameters was hypothesised to complement and enhance the use of layering techniques.

Broadly speaking, whilst this was the last production technique to be applied to the production of the creative work, in many respects it was one of the easiest to implement. Due to this ease of implementation, there was a fear of using technology in an overly simplistic fashion that would erase the nuance of variation from production. At the beginning of this research, a hypothesis was tested that real-time performance actions would create more interesting results than anything that could be programmed, however as the research progressed, this is hypothesis no longer remained.

Rather than prioritising improvisation as the principal means for exploring development, the use of improvisation in an integrated way with Phasing LFO Processes and Incremental Parameter Automation has been implemented across the work. This is due to the different personalities that each production technique exerted on the work and the interest that was generated through the interactions between these techniques. Whereas Real-time Spontaneous Performance Interactions create greater variance of instrument and effect parameters, Incremental Parameter Automation allowed for gradual and barely perceptible change from repetition to repetition. This gradual change, when applied unidirectionally, was used to gradual yet persistent change in productions over time.

While different productions prioritised different processes, with the exceptions of *DDL SDA* and *Melting,* all productions retained elements of all three processes, as seen in Fig. 5.01. This can also be observed across the seven analyses tables presented in the Production Analyses Appendix 1, which isolate how different production techniques were implemented across all instrument tracks of seven of the eleven creative works.

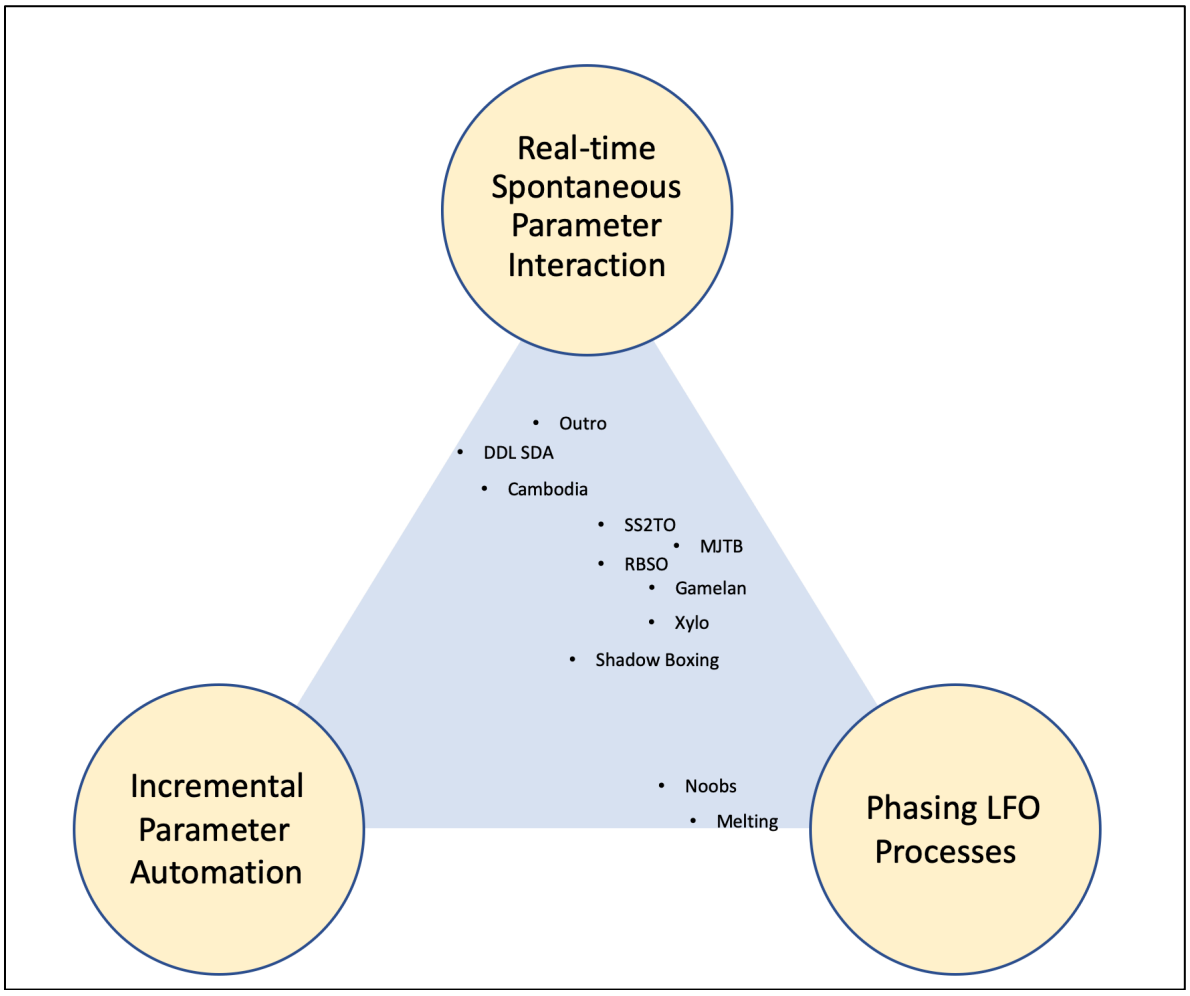

Fig. 5.01 – Details the ratio of the three principal production techniques applied across the folio, where productions marked at the centre of the triangle used all three techniques in equal measure.

When observing the effect on result when these processes are contrasted, it should be asked what the musical differences between productions at the extremes of the spectrum are. Subjectively at least, Noobs and Melting seem to possess more nihilistic, brutalist flavours whereas Intro, Cambodia and DDL SDA are more emotive, with less control and symmetry.

Through the production of the creative work, an increased awareness has developed of how the role of producer differs from that of a performer. The producer is afforded the opportunity to be outside the performance process of the music and is not always required to be physically engaged. This opportunity allows the producer to consider the many options and decision processes at play within the production; to work reflectively, rather than reflexively.

While the implementation of assigning an extended, incremental automation parameter is straight forward, there are many options to consider: What is the ideal degree of variation? What is the ideal rate of variation? Does variation to one parameter require change to another? Many synth parameters work together; such as filter resonance and cut-off; and attack, decay, sustain and release controls. When using return track sends to an external effect, the nature of the effect needs to be considered. Does the return track effect need to be equalised to be better balanced in the mix? Do the time values of the reverb or delay need to be changed? Would the effect benefit from the assignment of an LFO to a parameter? If so, at what rate or depth? These types of questions and more are persistent and constant as a production moves from genesis to completion and are carried out through the editing stage of the production process (as discussed later in more details, regarding Fig. 5.08)

While the action of implementation of Incremental Parameter Automation is straightforward, the consideration of potential knock-on effects when trying to create development is more complicated. Analyses of the use of Incremental Parameter Automation, as detailed in the Production Analyses chapter, shows that on many occasions, this technique was used to send additional volume to Return Tracks containing reverb and delay effects. Often these delay effects generate additional 1:1.5 ratio polyrhythmic information (see Chapter 2) through the use of dotted 1/8th and dotted ¼ note delay times. In the instrument track *SS2TO: 3/16ths*, seen here in Fig. 5.02, Incremental Parameter Automation to send volume to Return Tracks containing reverb (B and D) and a dotted ¼ note ping-pong delay has been used to add density and space through the incremental addition of reverb, whilst the polyrhythm found in the track's single pulsing dotted 1/8th note is reinforced by the incremental addition of a dotted ¼ note ping-pong delay.

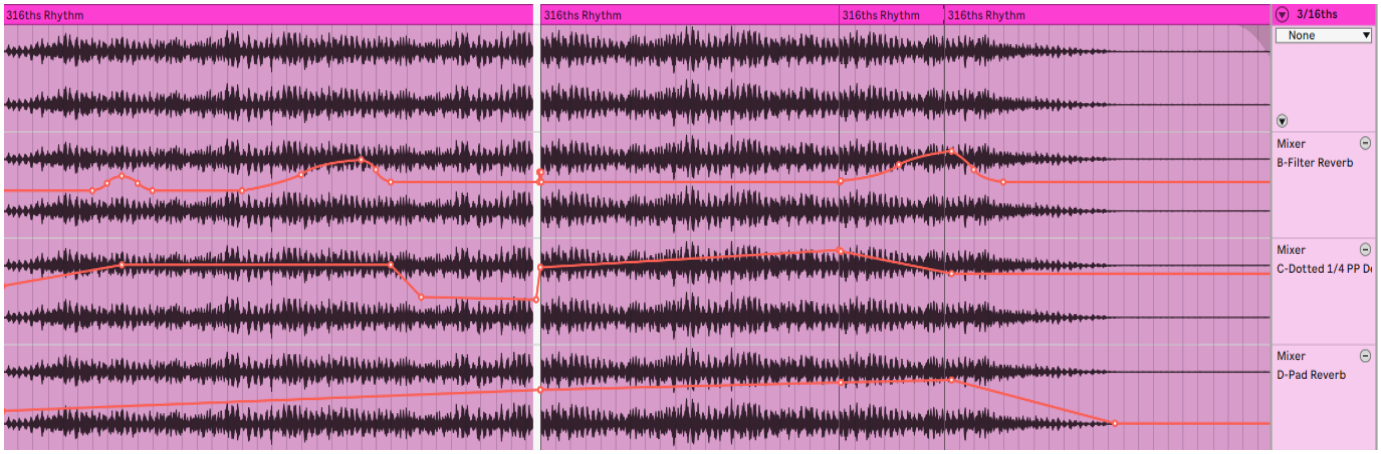

Fig. 5.02 – Incremental Parameter Automation assigned to *SS2TO: 3/16ths*

Not only were Incremental Automation Parameters used to control send volume from instrument tracks, but this control was used to change parameters of Return Track effects. For instance, in *Shadow Boxing,* the delay feedback on Return Tracks B and C are automated to increase at different points throughout the production (Fig 5.03)

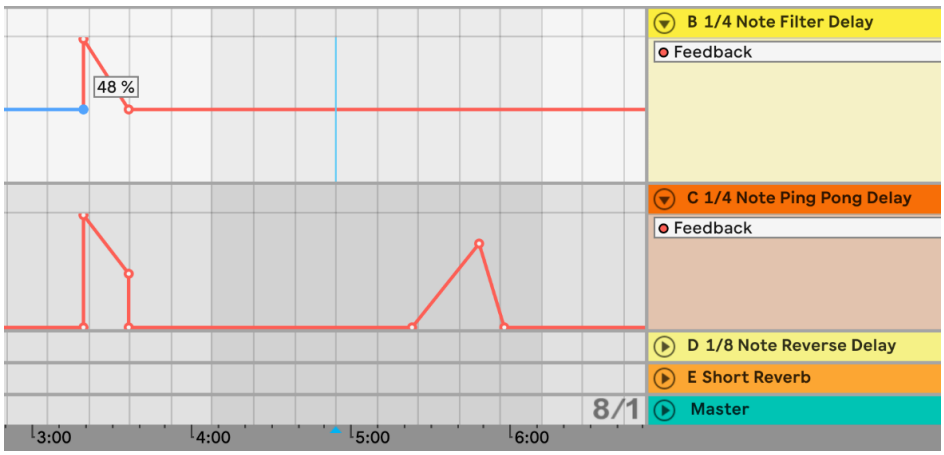

Fig. 5.03 – *Shadow Boxing* – Incremental Parameter Automation assigned to the feedback parameter of different delay units across two Return Tracks

Uses of Incremental Automation Parameters to control volume sends to Return Tracks is prevalent throughout the folio, with specific instances detailed in the Production Tables of the Production Analyses Chapter. One more visual example is presented here in Fig. 5.04, 5.05, from *Gamelan: Mopho* and *Gamelan: Melody* where assignments to reverb and delay effects on return tracks, as well as the decay on the *Melody* instrument track utilise Incremental Parameter Automation.

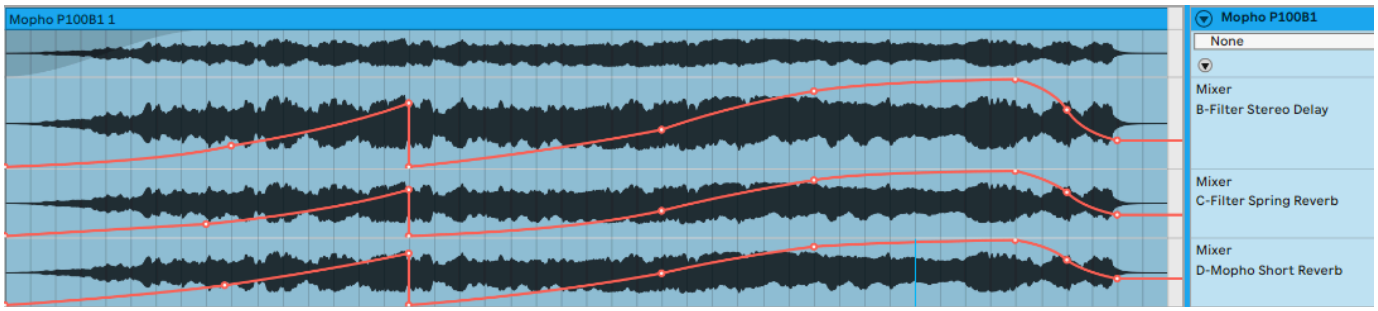

Fig. 5.04 – Incremental Parameter Automation to reverb and delay effects on return tracks on the instrument track *Gamelan: Mopho*

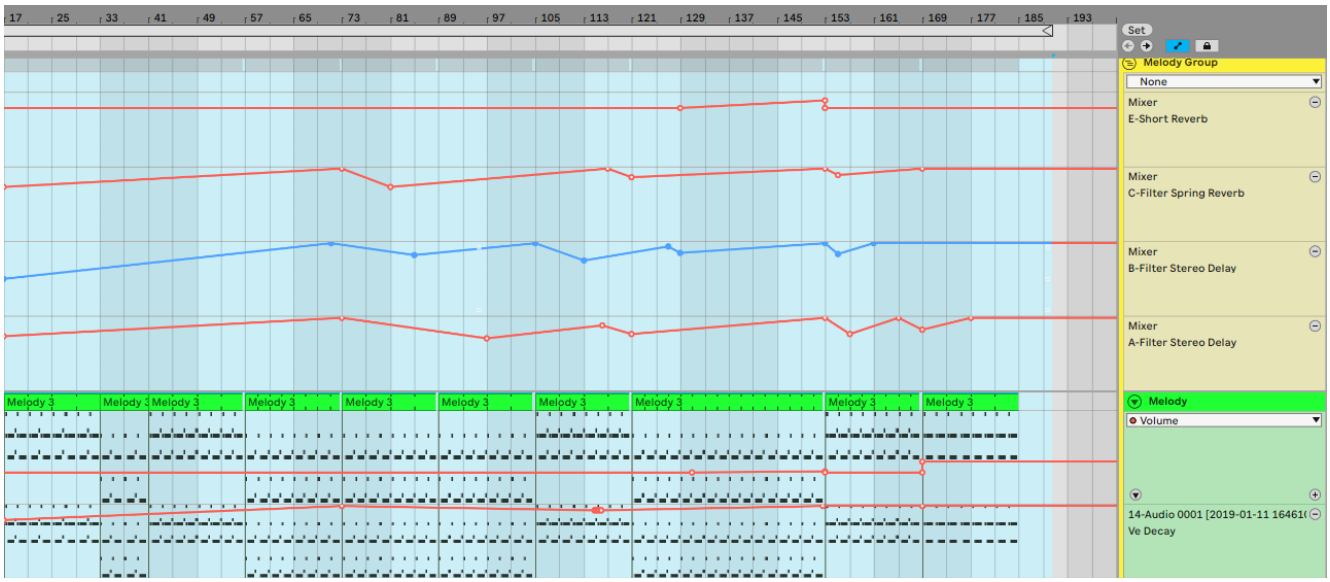

Fig. 5.05 – Incremental Parameter Automation to reverb and delay effects on return tracks, as well as the decay value on the sampler used on the instrument track *Gamelan: Melody*.

Additionally, Incremental Parameter Automation was added in conjunction with other production techniques such as Real-time Spontaneous Parameter Interactions, often to the same instrument track. In this example from *RBSO: Indie Roll,* send volume is automated to a dotted 1/8th note delay while real-time interactions determine send volume to a stereo 1/8th+dotted 1/8th note delay and amplitude decay (Fig. 5.06)

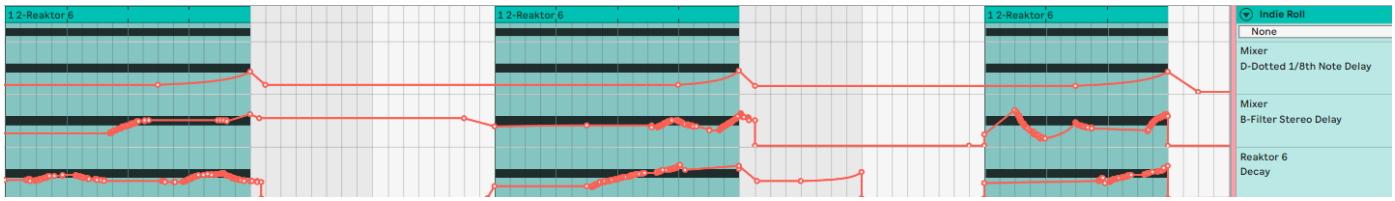

Fig. 5.06 – *RBSO: Indie Roll*, Incremental Parameter Automation combined with Real-time Spontaneous Parameter Interactions

Similarly, in the instrument track *RBSO: Reaktor6* (Fig. 5.07), Incremental Parameter Automation to send volume to a Return Track containing a dotted 1/8th note delay effect, whilst changes to the mix between synthesiser oscillators and FM settings were made through Real-time Spontaneous Parameter Interactions.

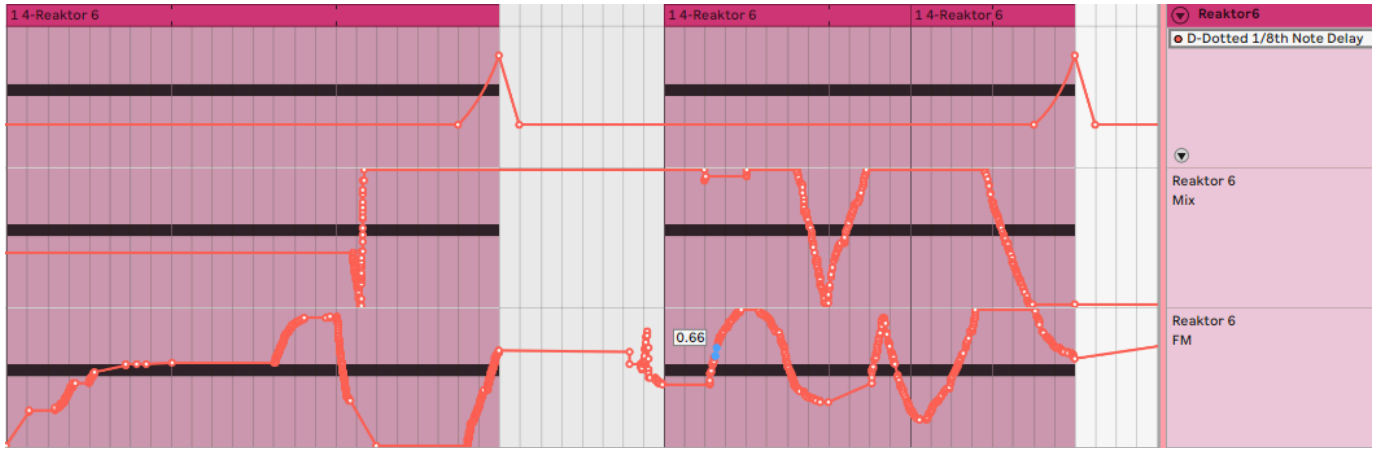

Fig. 5.07 – *RBSO: Reaktor6*, Real-time Performance Interactions combined with Incremental Parameter Automation.

To summarise, Incremental Parameter Automation is used to further accentuate production development. These accentuations create gradual change through the slow increase or decrease of parameter values. Whilst the assignment of gradual processes to automation is similar here to the assignment of LFOs, LFOs create gradual change in a cyclical way, whereas the use of automation here is linear and is used to accentuate development over time. This creation of Incremental Parameter Automation is a contemplative and less reflexive production technique, when compared to Real-time Spontaneous Performance Interactions.

As discussed in Chapter 4, the process of audio creation moved in a cyclical three-stage process (see Fig. 5.08). As productions progressed, Incremental Parameter Automation was added as part of the editing process, to enhance the feeling of linear development. As the creative process moved through the stage many times, the different production methods employed between stages became more tightly integrated and the distinction around which creative concepts emerged from what stage became less defined.

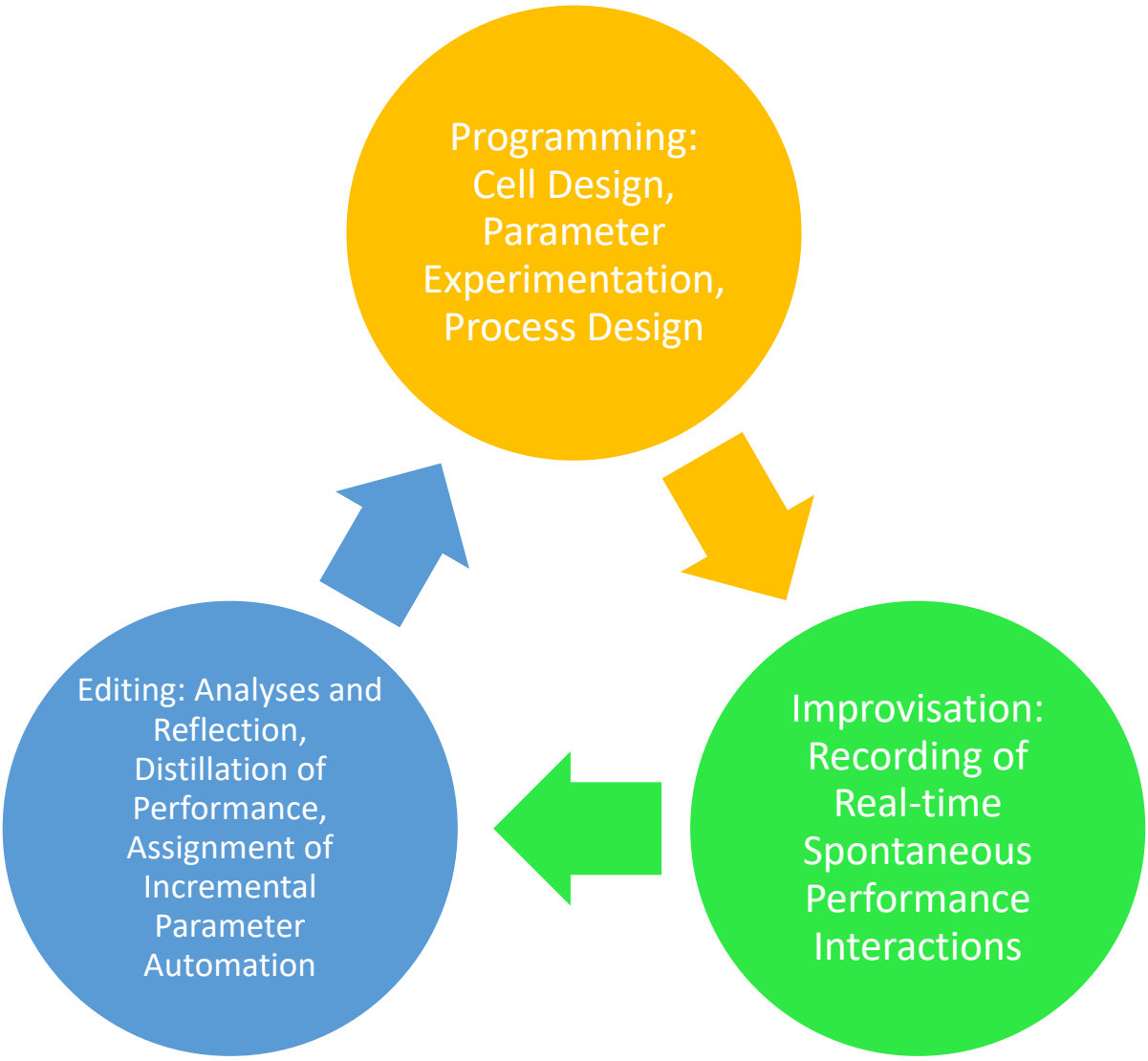

Fig. 5.08 – Three-step creative process employed for the completion of audio work

- Programming: The first creative stage where audio cells are composed (Chapter 1), suitable instrumentation for the voicing of the cell is found, polyrhythms between cells are experimented with (Chapter 2), LFO Processes are designed to create macro non-repeating structures from multiple cellular sine waves oscillations, set to non-synchronised interval values and assigned to instrument and effect parameters (Chapter 3).

- Improvisation: The creation of form through the deployment and cessation of cells, Real-time Performance Interactions with instrument and effect parameters (Chapter 4).

- Editing: Analysis and reflection, distillation of performance, removal of extraneous layers, assigning of Incremental Parameter Automation to instrument and effect parameters (Chapter 5)

Chapter 6

Integration of Audio Production Concepts into Audio-Visual Work

Central to this research has been a study of how the concepts of repetition and development explored in the creation of the audio work could be explored in audio-visual media. This led to investigations into vision-based software in an attempt to discover successful methods to create a synchronous and conceptually integrated audio-visual work.

At the outset of the research project, where investigations focussed on real-time spontaneous interactions with audio software, the vision-based software Touch Designer was seen as an ideal choice to partner with the Ableton Live, as its effect parameters could also be controlled in real-time. Initially, experiments were made exploring methods to visually represent the controller data generated through real-time performance interactions in Ableton Live.

Initial experiments with movie sampling attempted to integrate video footage that represented real-life occurrences in a non-real-time way. Real-life events were used as source footage, rather than more abstract or computer-driven imagery to provide a visual analogy to the real-time, humanistic interactions of performance that form a component of the audio production aspect of this research. Investigations into suitable non-real-time footage included the study of time-lapse videos, where a twenty-four-hour period could be played over a few minutes. As the audio work sought to represent non-linear time experiences through the use of minimal cellular repetition, it was hypothesised that repeating time-lapse footage of a twenty-four-hour period could provide suitable raw material to generate synchronous audio-visual work when used as a repeating cell.

The first efforts applying Ableton controller data to the time-lapse video footage work were mostly unsatisfactory. The jerky, non-linear interactions that worked well during improvisations translated as overly glitchy, manic and unfocused when applied to visual effect parameters. Alternatively, attempts to moderate the input data through the use of Math Chops (operators within Touch Designer used to manipulate input data to more user-friendly mathematical ranges) would create visual changes that were barely perceptible, to the point of non-engagement by the viewer. Through both attempts, the objective of creating hypnotic, plateau-type experiences and non-linear time perception were not achieved.

As well as the Ableton controller data proving unsuitable to assign to visual effect parameters, the loop of a twenty-four-hour period was too long to enable many cellular repetitions within the audio length of each production. If the video was sped up to enable more repetitions, the imagery became too manic to represent the audio synchronously. Of the final audio-visual work presented, only *Outro* uses time-lapse video, a sample of a New York horizon over 24hrs. It is visually processed using mirror, emboss and monochrome effects and is stretched to fit the 3:45 duration of the audio, playing only once and not as a loop. There is no real-time interaction or mapping of controller data to the visual effects. The natural ebbs and flows of the source video sample were deemed to be a suitable complement to the audio, produced by performing five single note instrument tracks on a Dave Smith Evolver hardware synthesiser, through a Roland Re-201 Space Echo delay effect.

Investigations into non-linear pictorial representations of time led to experiments with video samples of an opposite kind, slow-motion video. It was found many of the slow-motion videos captured featured a video subject moving against a static background. The nature of much super-slow-motion video requires the camera to be stationary while filming, enabling the focus and lighting of the subject to be seen clearly despite the very high frame rate. When using sampled footage of a subject moving in slow motion against a stationary background, it was possible to composite multiple copies of the video onto itself, with interesting visual effects created if the copies played at different speeds. Using a suitable composite mode such as 'difference' or 'negate' enabled the creation of a video where the background remained unchanged, yet the difference between the position of the subject's movements, due to the different speeds of the multiple copies became visible.

As the experiments with the audio-visual work began to explore this new process, concurrently, the audio work began to move away from focussing exclusively on performance interactions and towards integrating autonomous process-driven concepts such as the use of Phasing LFO parameter assignments, inspired by the tape work of Steve Reich. In the work "Come Out" a repeated vocal phrase gradually moves out of phase across four tape heads, moving from a tangible audio representation of a voice sample to something more abstract.[66] With the discovery that the same video cell played simultaneously at different speeds could be composited to create an image that would move out of phase with itself, a visual representation of the process-driven conceptual framework behind Reich's tape work, as well as the Phasing LFO Processes of the creative work began to be explored.

The 'Movie In' operator, a module within Touch Designer that allows the video footage to be played within the project file, contains parameter controls which enable both synchronised play between the multiple copies of the operator, as well as different speed controls. A picture of this operator and its controls are seen below in Fig. 6.01. A pulse control (Fig. 6.01 – 2), which when synchronised to an output control in Ableton, can be used start or re-start all 'Movie In' operators together, allowing for all video files to be synchronised, before gradually drifting out phase with one another. The Speed control (Fig. 6.02 – 3) allows the speed of a module's playback to be faster or slower, with a value of 1 meaning play speed was unaltered.

[66] Andy Beta, “Blood and Echoes: The Story of Come Out, Steve Reich’s Civil Rights Era Masterpiece,” Pitchfork (Pitchfork, April 28, 2016), https://pitchfork.com/features/article/9886-blood-and-echoes-the-story-of-come-out-steve-reichs-civil-rights-era-masterpiece/. (accessed Mar 17, 2019)

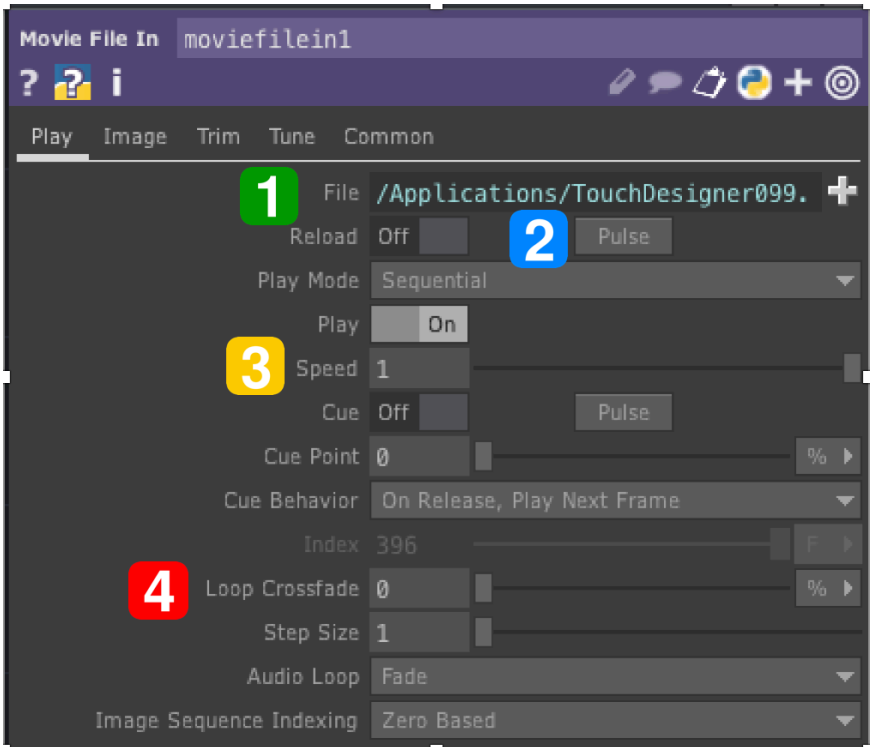

Fig. 6.01 – Control window for a Touch Designer 'Movie In' Top operator.

1. Multiple instances of the operator can be added to a Touch Designer project but still reference a single video file
2. Pulse control - when assigned to a single Ableton controller can enable all operators to start playing the video sample at precisely the same time. This allows all video samples to synchronise before gradually drifting out of time with one another
3. Speed control – a different value can be assigned to each operator so that the same video file can be played simultaneously at different speeds. Change to this control between operators affects how quickly the videos drift out of phase with each other
4. Loop Crossfade – enables the loop to fade out and fade in through the transition of the video restarting

The Loop Crossfade (Fig. 6.01 – 4) was used blend the restart of each video cell in *Xylo, Cambodia, Melting, Noobs* and *SS2 TO* but not used for *Shadow Boxing, Gamelans, RBSO* and *DDL SDA*. In these latter instances, this 'jerking' effect of the video cell restarting was timed to represent the start of a new musical section visually.

The video speeds of all videos (except *Cambodia, Melting* and *Outro*) were adjusted so the primary, top layered video of the composite would loop precisely in time with either 8, 16 or 32-bar phrases. Here, with shorter video samples, the idea of cellular repetition was more fully represented within the video, employing a method more analogous to the audio work when compared to the use of looping time-lapse footage. The syncing of video repeating video cells to audio phrases allowed visual marking of new musical sections, as much of the audio work was written within these phrases. Where crossfading of the video was not used, the sudden visual 'jerk' of the video clip re-starting aligned with the phrasing in the audio. For instance, in *RBSO*, the slow-motion hummingbird footage re-starts every 32 bars, aligning with the introduction of the *RBSO: Ride* instrument track at 2:08 and 4:09. It also aligns with the introduction of the *RBSO: Indie Roll* instrument track at 1:02 and the re-introduction of the *RBSO: HiHat* instrument track at 6:13.

The following table (Table 6.02) shows the production, the original footage length of the video sample, the time required to play a 16 or 32-bar phrase at the bpm of the production and the resulting speed setting used for the top layer of the video composite.

Production	Footage	Length (seconds)	Phrase length (seconds)	'Movie In' Speed Value
1. Xylo	Slow Side Water	30.92	31.475 (16 bars @ 122 bpm)	1.018*
2. Cambodia	Breakdance 1, Breakdance 2	2 mins 19 sec, 1 min 6 sec	Video length not synced	No change
3. Melting	Coin Toss	67:95	Video length not synced	No change
4. Noobs	Opening Flower	25.16	50.088 (four 6 bar phrases @ 115 bpm)	0.502*
5. Shadow Boxing	Bouncing Cubes	22.95	30.97 (16 bars @ 124 bpm) 61.94 (32 bars @ 124 bpm)	0.74 0.37
6. Gamelans	Acrobat 1, Acrobat 2	24.60, 31.93	30.97 (16 bars @ 124 bpm)	0.63 0.97
7. RBSO	Hummingbird	31.80	61.94 (32 bars @ 124 bpm)	0.513
8. MJTB	Ballet	22.37	30.97 (16 bars @ 124 bpm)	0.722*
9. DDL SDA	Broken Record	8.16	15.48 (8 bars @ 124 bpm)	0.531
10. SS2 TO	Taekwondo	18.38	30.97 (16 bars @ 124 bpm)	0.594*
11. Outro	New York	2 mins 31 sec	3 min 45 sec	0.671

Table 6.02 – Original video sample used, and speed adjustments made. *Additional modifications had to be made to compensate for crossfading of the restart of each video cell, which shortened the overall length.

For the most part, the audio was well on the way to completion before work on the audio-visual component had begun. However, it should be noted that through the improvisation process used for the creation of form from repeating cells, the cueing of instrument tracks didn't always relate to 8, 16 and 32-bar sections, particularly on productions such as *DDL SDA* and *Cambodia* which were heavily reliant on real-time spontaneous interactions with instrument track parameters to generate tonal variation and development over time. These tracks were later edited to more closely follow 8-bar phrases, to synchronise with the repeating video cells of the audio-visual work.

While this process closely resembles methods of video-clip production, as well as VJing - where audio-visual components are designed to complement pre-existing audio, further research into more closely integrated processes between vision and audio could generate interesting comparative results. For instance, the rhythm of an audio cell could be designed to punctuate the visual movements of an audio-visual cell. Alternatively, cyclical lengths of the audio and audio-visual cells could be designed, so the rate of repetition expands synchronously over time.

The productions *Cambodia, Melting* and *Outro* did not use synchronised video cells as their form did not strongly evoke 8, 16 or 32-bars. *Cambodia's* primary melodic instrument *Cambodia: Kontakt Piano* and *Cambodia: 8ve Piano* saw extensive use of real-time

spontaneous parameter interactions, so whilst built on a repeating cell, extended footage of the break-dancer complemented this aspect of performance, rather than using a shorter video cell. *Melting's* extended drones felt better complemented by the protracted video of the coin toss. *Outro* employed different compositional elements when compared to the other productions in the folio, such as the use of only melodic synth notes and no percussion. As this audio production differed, it made representative sense at least to use a different method of audio-visual synchronisation. The audio production *Noobs* was built around 6-bar phrases, not 8 or 16-bar phrases, so the video cell of the opening flower footage was adjusted to fit this length.

The use of image phasing between multiple instances of the same video cell was found to work most effectively when paired with the concept of moving from the tangible to the abstract, as it had been in the audio work. Hence, once the top video cell layer had been determined, the subsequent video speeds were designed to gradually move out of phase as the work progressed. However, attention was given to not enable this process to occur too quickly or slowly, given the length of the audio. As phasing becomes more pronounced as the audio progresses, the difference in the position of the subject becomes more accentuated with every repetition. The table below (Table 6.03) shows the Speed times for all 'Movie In' operators throughout the creative work.

	1. Xylo	2. Cambodia	3. Melting	4. Noobs	5. Shadow Boxing	6. Gamelans	7. RBSO	8. MJTB	9. DDL SDA	10. SS2TO	11. Outro
Speed MI:1	1.018	1	2	0.50	0.74	0.79	0.513	0.72	0.53	0.592	0.671
Speed MI:2	0.76	0.99	1.5	0.49	0.73	0.8	0.508	0.71	0.52	0.588	-
Speed MI:3	1.018	0.98	0.5	0.48	0.72	0.81	0.503	0.70	0.51	0.586	-
Speed MI:4	0.76	0.97	0.9	0.47	0.71	0.82	0.498	0.69	0.50	0.584	-
Speed MI:5	-	1	2.01	0.46	0.37	0.97	0.493	0.68	0.49	0.582	-
Speed MI:6	-	0.99	1.49	0.45	0.36	0.96	0.488	0.67	0.48	0.580	-
Speed MI:7	-	0.98	0.5	0.44	0.35	0.95	0.483	0.66	0.47	0.578	-
Speed MI:8	-	0.97	0.9	0.43	0.34	0.94	0.478	0.65	0.46	0.576	-

Fig 6.03 – Shows playback speeds of the eight different 'Movie In' operators found within each Touch Designer project. Blue table items indicate where the original video sample was used as a mirrored image. Green and red table items show where two different video samples within the same audio-visual project.

While most tracks explored the use of incremental phasing, *Xylo* explored a version of the 1:1.5 ratio regularly found throughout the polyrhythmic investigations of the audio work. Here the original 1.018 speed was multiplied by 1.5 to create a 3:2 ratio, but the resulting video was too fast to pair suitably with the audio, so the value was halved at a result of 0.76. *Melting* uses ratio relationships between videos instances, as well as some phasing interaction. Here, the original speed 1 is not stated but inferred a base to which all playback Speed values relate. The ratio of 2:1 is used in the playback speed '2' and '0.5', while the ratio 1:1.5 is used in the playback speed 1.5. Values of 1.49 and 2.01 are used to phase

against their mirror image, marked in the table in blue. *Shadow Boxing* uses a single video as two groups of phasing images, one playing to synchronise with 32-bar phrases and the other synchronising with 64-bar phrases.

The audio-visual work *Gamelan* was created through the use of two video samples of the same acrobat; the first of an anti-clockwise backflip, the second of a clockwise backflip. Four operators play each of the two video samples; the speed value for each operator can be seen in Table X. The images in Fig. 6.04 on the following page are stills taken from the audio-visual work *Gamelan*. They demonstrate the phasing effect between each group of non-synchronised composited videos, with the differences in the movements between videos becoming more accentuated over time. The image becomes additionally abstract as the compositing of the second video group behind the first becomes more visible. This second group also phases as the work progresses. The order of the two groups is automated to change throughout to accentuate the change of octave in the *Gamelan: Melody* instrument track at 1:18, 1:50, 2:20, 2:51, 3:22, 3:53, 4:55, 5:26.

Gamelans - 0:30

Gamelans -1:01

Gamelans - 1:49

Gamelans - 4:00

Gamelans – 4:32

Fig. 6.04 – Audio-visual footage demonstrating the increase in phasing effects of the visual layers as *Gamelan* progresses

The layout for the Touch Designer set for *Gamelan* can be seen adjacently on pg39. The 47 operators are placed for more straightforward navigation, with information flowing between operators from left to right, starting with the inputs from Ableton on the far-left through to the video output on the far-right. The purple lines mark the path of the video processing; grey lines with arrows mark the control parameters from Ableton.

Fig. 6.05 - *Gamelan*: Touch Designer set: Layout of Operators

1. Ableton Controller CHOP Operators – eight different operators receive data values from the eight different macro values from the TD Controller instrument track in Ableton. Data values are from 0-127

2. Math CHOP Operators – operators change the number value of the 0-127 Ableton input data to a range suitable for the TD parameter to be controlled

3. Movie-In TOP Operators – two banks of four operators, with each bank playing either the Acrobat 1 or the Acrobat 2 video sample. Here videos are synced to start simultaneously (by the first Ableton Controller), and their playback speeds are set to both synchronise with 16-bar phrases of the audio and to phase with another.

4. Level TOP Operators – eight Level operators are assigned to each Movie In operator to control the opacity of each video sample. When the control is used as an on/off binary, different Movie In videos can be made visible or turned off, while enabling the phasing process between images to occur, even if the phasing isn't visible. In this way, a single clip of the acrobat beginning his flip can be seen at the beginning of the audio-visual.

5. Composite TOP Operators – the first two composite operators combine each group of videos using a 'difference' and a 'negate' composite, before being connected with a third composite operator using an 'outside luminance' composite to create a single image. Throughout the work, the composite order of the two layers is synchronised to the change in octave of the melody instrument track. The first, a backflip moving anti-clockwise on-screen, changes with the second, a backflip moving clockwise on the screen. When a layer is moved to the back, it can still be seen through the white areas of the front layer.

6. Level Operator – another level operator has been used on the final image to add incremental parameter control of the final image's contrast, as well as add an adjustment to invert the black and white.

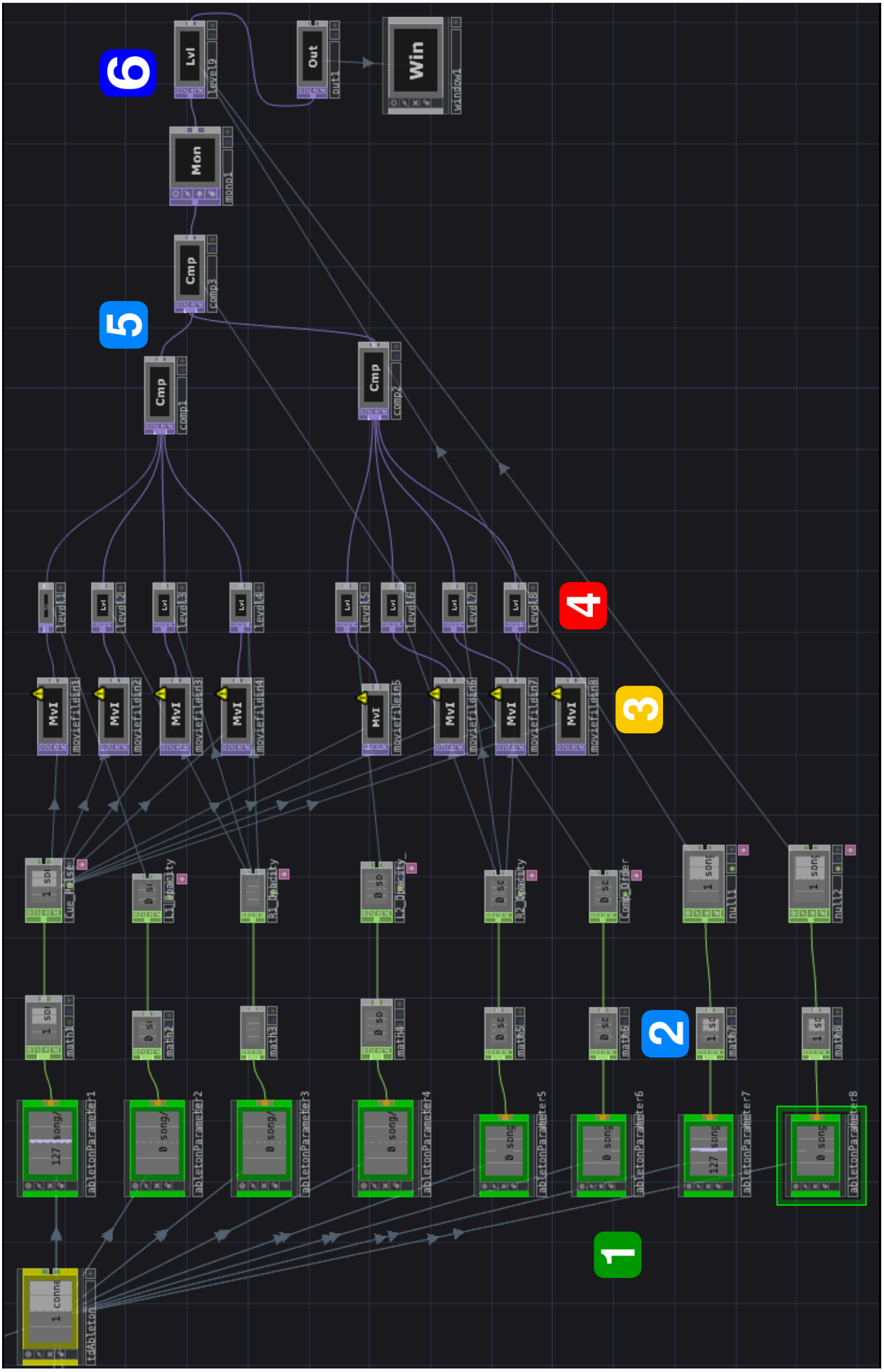

Fig. 6.05 - *Gamelan:* Touch Designer set layout

As research progressed and phasing processes began to be adopted into the audio-visual work, as it had done in the audio work, there was a shift away from representing real-time performance actions in the audio-visual work. The adoption of autonomous processes meant that once created and set into motion; no further interaction was required for the process to continue. In this way, the audio-visual work began to detach from the literal representation of audio data to the representation of production concepts found throughout the audio work. Eventually, methods for adopting all five production concepts explored in the audio work – cellular repetition, polyrhythmic devices, real-time spontaneous human interaction (although not parameter), phasing processes and incremental parameter automation change, were conceptually represented throughout the audio-visual work.

Consequently, the Ableton sets controlling Touch Designer could be modified from their original form to better enable the representation of the production concepts, rather than a literal representation of Ableton parameter data. Instead of assigning data directly from the Ableton set, a new track was created in Ableton with a macro instrument inserted. This instrument served no purpose other than to control the Touch Designer set. In keeping with conceptual representation, a maximum of only eight macros were used to control the Ableton set, as with all productions, at least in their inception, there had only been eight instrument tracks. Accordingly, in the Touch Designer sets, a maximum of eight 'Movie In' operators playing video samples were used. Adjacent is the automation data created in Ableton Live to control the *Gamelan* Touch Designer set. The changes to all eight macro outputs which are sent via a network to Touch Designer are seen here.

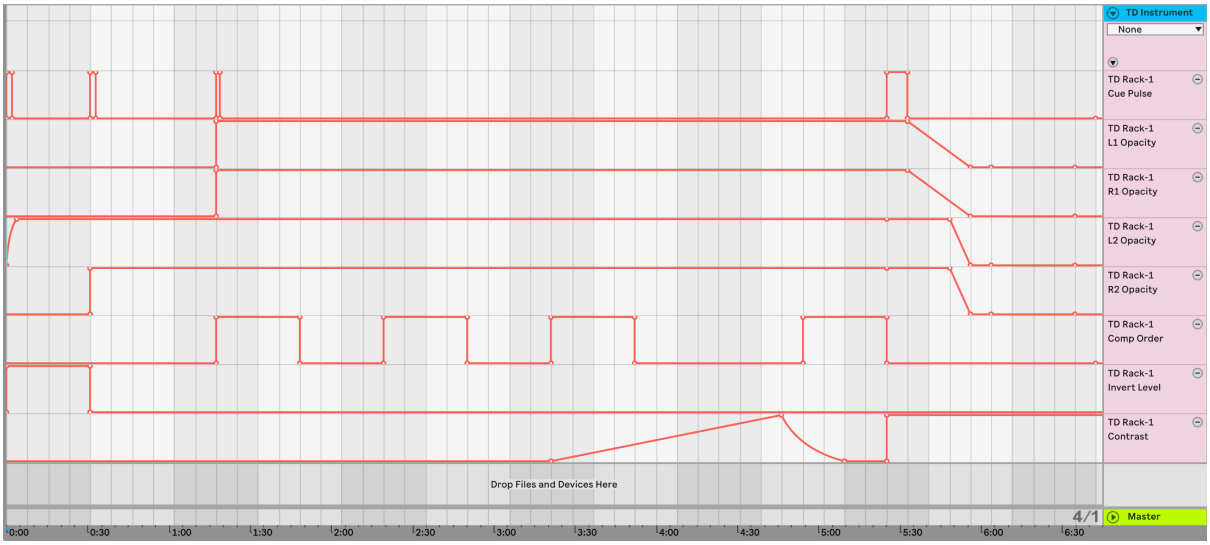

Fig. 6.06 – Automation data assigned to Ableton Live macros in a TD Ableton rack, assigned to control the eight Ableton inputs of the *Gamelan* Touch Designer set (Fig.6.05 – 1)

- Cue Pulse – synchronises the start of all eight 'Movie In' operators (Fig. 6.05 – 3)
- L1 Opacity – makes the top video of the composite of the first video group visible (Fig. X – 4) at the output
- R1 Opacity – makes the remaining videos in the first group visible (Fig. 6.05 – 4) at the output
- L2 Opacity – makes the top video of the composite of the second video group visible (Fig. 6.05 – 4) at the output
- R2 Opacity – makes the remaining videos in the second group visible (Fig. 6.05 – 4) at the output
- Comp Order – changes the order of the composite of the two video groups (Fig. 6.05 – 5)
- Invert Level – inverts the black and white colour (Fig. 6.05 – 6)
- Contrast – incremental automation of the final image's contrast controls (Fig. 6.05 – 6)

The conceptual exploration, rather than the literal representation, of the production concepts researched in the audio of the creative work provided an opportunity for further integration between the two media than was anticipated during the early adoption of this method.

As previously stated, the sampling of movie files that featured slow-motion footage was a technique used to explore the non-linear time perceptions that are a central concept of techno and repetitive minimal music generally. This concept of non-linear time exploration was explored in the audio-visual work. As the repeating video cells phase further and further apart, the physical actions stop being represented in linear time and move to be represented more temporally, where past and future tenses disappear, and all moments are depicted concurrently. For instance, in the audio-visual project *SS2TO*, at the outset of the work, a taekwondo practitioner moves from jumping, kicking a tile to landing on a mat. But as the work progresses and the videos phase further apart, all these actions begin to occur simultaneously - the tile is both about to be broken, breaking and broken all at once. Similarly, in *Noobs* the flower comes to be both blooming and dying, the result of the coin toss in *Melting* is both known and unknown, the vinyl record of *DDL SDA* is both unbroken, breaking and broken. In this way, the audio-visual work has sought to create a literal representation of the temporal and hypnotic effects of the audio based on cellular repetition.

As experiments with the representation of real-time spontaneous interactions from Ableton Live in Touch Designer fell short, there was concern that the humanistic and organic components of the productions would not be represented in the visual component of the work. Touch Designer is broad in scope by design and is used professionally in many different ways. One such use is the generation of 3D animations from components, and interactions with these animations could have been a way to represent the audio data from Ableton visually. Using Touch Designer in this way can be seen in the work of audio-visual artists Matthew Ragan[67] and Umbrella Buddha[68] who animate 3D models of abstract shapes, using data cues from Ableton. However, the choice was made to use movie samples of real-world organic imagery such as a ballet dancer (*MJTB*), acrobat (*Gamelan*), flower opening (*Noobs*) or hummingbird (*RBSO*). The use of this type of imagery as raw material seeks to represent the human interactions with autonomous processes of the software as a concept, rather than a direct representation of the results of these interactions.

While real-time audio interactions with controller data are not represented within the audio-visual projects, changes and development of form through the layering of instrumental track cells, also a product of improvisation, are expressed through the use of video effects to denote these changes. For example, in *Gamelan*, the overlay order of the two video samples changes at many of the important form points, such as when the melody cell changes octave. In *Shadow Boxing*, different layers of video are turned on and off as different audio cells are turned on and off, creating changes to visual density to match the changes in aural density.

Black and white imagery was used for all audio-visual presentations to integrate the disparate sources of video samples used through the eleven audio-visual works. All video sample cells were initially in colour, so the use of monochrome effects throughout the Touch Designer sets enabled the finished audio-visual works to take on a similar look. In this way, all eleven pieces could come to represent components of a macro work, rather than as separate stand-alone pieces.

The use of black and white graphic design and video is found throughout techno's canon, in particular from the last twenty years. Shed's 'The Traveller', 'Shedding the Past' and 'The Killer' are all in black and white, so too are the album covers for Marcell Dettman's 'Phantom Studies', 'DJ Kicks', 'Seduction' and 'Quicksand' releases. Andy Stott's post-techno LP's 'It Should Be Us', 'Too Many Voices', 'Faith In Strangers' and 'Luxury Problems' feature black and white pictures of organic imagery. The music video for Shed's 'I Come By Night' features prominent lighting effects and is shot in black and white, so too are the music videos for Dettman's 'Emika', Blawan's 'Tuesday's March' and Small People's 'Down Over Me'.

Lastly, Extended Incremental Automation of Parameters became to form an integral part of the audio-visual work. This technique enabled gradual change to the repeating video cells

[67]Matthew Ragan, "AME 394 | Simple VJ Set-Up | TouchDesigner," Matthew Ragan, March 30, 2015, https://matthewragan.com/2015/03/29/ame-394-simple-VJ-set-up-touchdesigner. (accessed Jan 14, 2020)

[68] Umbrella Buddha, "Touch Designer VJ Engine - Test14," YouTube Video, *YouTube*, June 28, 2015, https://www.youtube.com/watch?v=M6o76FjzZiI. (accessed Jan 14, 2020)

and became an important component establishing linear development through time. To create a connection between all pieces of the creative work, similar effects were employed using extended automation parameters. The 'Feedback Edge' image filter, designed using multiple operators, was applied to *Xylo,* seen here in Fig X, as well as *Cambodia* and *SS2TO*, with the effect growing in prominence throughout the latter half of these works. Incremental automation to lighting level parameters such as contrast, gamma, exposure and black level were also used throughout. This Incremental Parameter Automation in the audio-visual work can be seen again here in *Xylo* (Fig. 6.07) and *Gamelan* (Fig. 6.06).

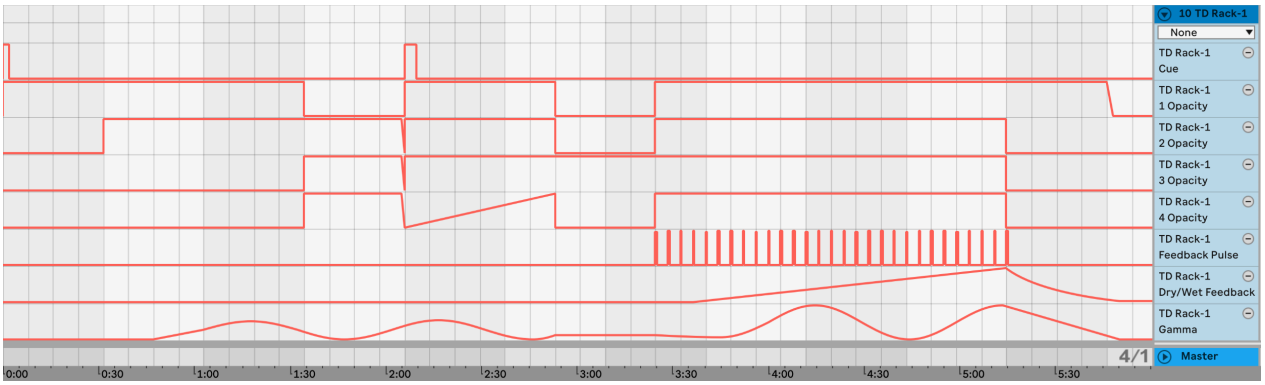

Fig. 6.07 – Touch Designer *Xylo* automation data from Ableton. Incremental automation to video opacity can be seen on Macro 4 from 2:10-2:50, dry/wet control of the Feedback Edge effect on Macro 7 from 3:30 to 5:45, gamma control of video lighting level on Macro 8 from 0:40 to 5:45.

As with the other production methods featured in the audio work and incorporated into the audio-visual, Incremental Parameter Automation was adopted as a concept rather than the direct assignment of Incremental Parameter Automation found within the instrument tracks of the audio work. It is a conceptual principle found in the audio work that has been applied broadly to enhance linear direction, created principally by phasing processes of overlayed repeating video cells.

To summarise, methods to represent the production concepts explored through the audio folio were found through conceptual, rather than the literal representation of ideas. Video footage of real-life events rather than computer-generated imagery was used to represented real-time spontaneous interactions. Form elements created in audio through real-time interaction could be represented by synchronised changes to the audio-visual media, such as correlating density of audio cells with density of image layering and the inversion of black and white colours. The temporal effects of audio repetition came to be represented through the use of slow-motion footage and cyclical use of video cells. The phasing LFO processes explored conceptually in the audio came to be represented visually, through the layering of multiple instances of the same video sample at slightly different speeds. Incremental Parameter Automation of visual effect parameters within Touch Designer allowed for an enhanced feeling of development over time, as this process had done during audio production. However, despite the technology allowing for automation parameters from the Ableton set to control the Touch Designer set, more effective results came from when the visual parameters were controlled non-synchronously from the audio work.

Finally, the adoption of a conceptual representation of the audio production techniques, rather than applying and transferring data created in one media to the other, allowed for greater connection and synchronicity between the audio and the visual components of the audio-visual media.

As a process, the creation of audio-visual media was implemented toward the end of the completion of the audio productions, a process not dissimilar to the creation of music videos, where the vision seeks to synchronise with and represent aspects of the music. Here, this process worked in tandem with the editing process of the three-step production process. While some elements were integrated, such as the editing of form or application of Incremental Automation Parameters, the process of audio-visual creation sought to be representative, rather than integrated with the audio process (see Fig. 6.08).

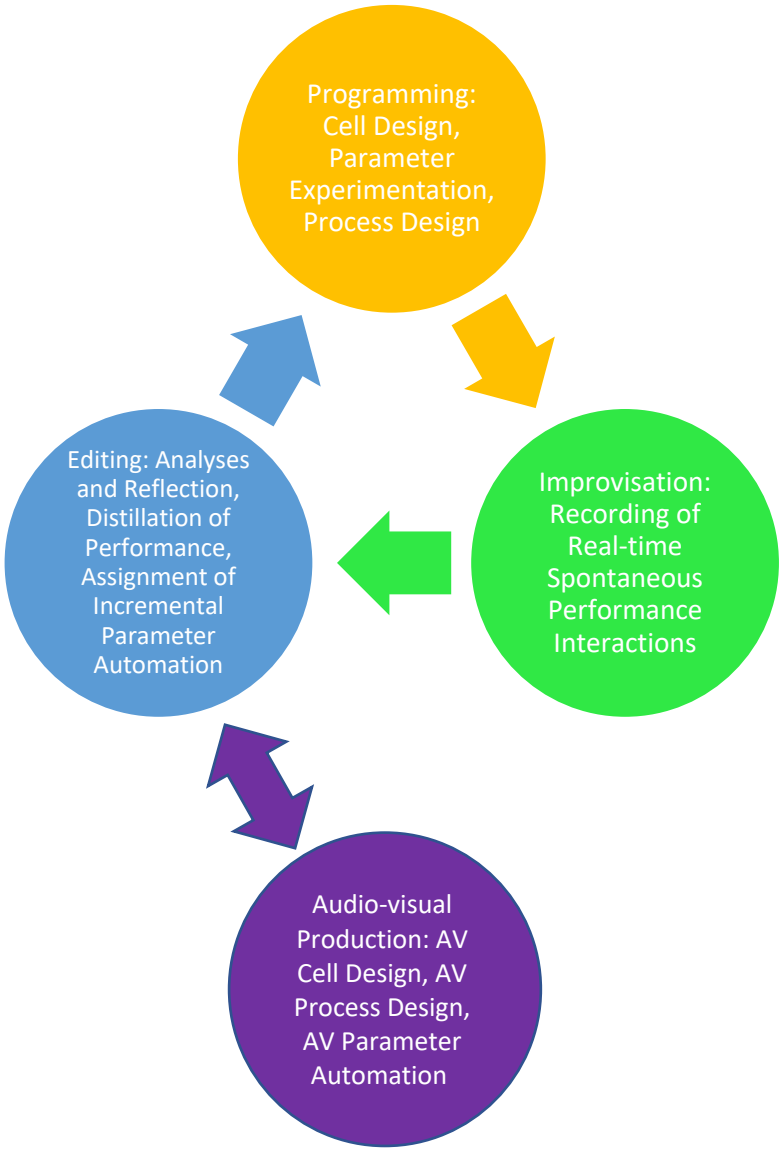

Fig. 6.08 – Representation of the full creative process with the addition of audio-visual production

Conclusion

Through practice-led research, investigations have been undertaken to further understand the relationship between cell repetition and the interaction with development over time. Understanding of how real-time spontaneous performance processes can be integrated with autonomous mechanical process have developed. Additionally, investigation into how the concepts explored in the production of audio can be represented in visual display to create synchronised audio-visual works.

Central to the gauging of the effectiveness of these experiments has been the exploration of temporal and non-linear experiences of time. Further study and analysis of the aesthetics of repetition in music and the generation of non-linear time experiences, in conjunction with creation of new work, would be a natural step to take after the completion of this thesis.

Additionally, the use of technology throughout the creation of the folio has been a collaborative process with technology. Further study into the collaborative process between human and technology in the generation of electronic music, particularly techno, could be a fertile area of research.

When working with repeating cells, the design of the cell itself was found to be important. Sparsity, and consistency of rhythmic sub-division, including quantisation, enabled cells to function both in isolation or as part of a macro whole, allowing development to occur through the addition and subtraction of instrumental track layers. The use of volume envelopes and time-synchronised delays further explored the concept of repeating cells existing as layers of effects, in addition to audio. Single cells on instrument tracks and pedal tones were used throughout, enabling greater scope for variation of timbre and density, as well as being more suited to the creation of temporal time experiences.

Repeating cells of different lengths across different instrument tracks were used to create simultaneous combinations of contrasting rhythms or polyrhythms. These polyrhythms take extended periods of time to resolve to the downbeat of an eight-beat phrase, the predominant length of phrase throughout the creative work. In this way, larger repeating macro structures were created from smaller repeating structures. A 1:1.5 ratio between different cell lengths was explored throughout the creative work. More complex ratios were investigated, such as those in *RBSO*; however, as these larger structures take longer to resolve, the feeling of repetition is less prevalent, potentially undermining the effect of repetition on temporality. Experiments with more complex ratios led to experiments with phasing processes, where repeating LFOs of different non-divisible lengths interacted with each another, to create incremental and gradual timbral change that was non-repeating through the duration of the production. The application of complex ratios to create phasing between repeating LFO cells to control instrument and effect parameters, rather than rhythmic polyrhythms, was deemed more successful and to have broader application.

Further research into the application of phasing LFO processes, such that more LFOs are assigned to fewer instrument tracks, while still working with short cellular repetitions of audio would seek to explore the limits of the application of this concept.

Improvisation was found to be an effective method to create form through a process of real-time performance, enabling linear structures to be generated from repeating cells in a non-predetermined way. Additionally, Real-time Performance Interactions to assigned instrument and effect parameters added musical variation to productions in a non-cyclical way, creating elements of 'human performance' integrating with autonomous and mechanical processes.

The assignment of Incremental Parameter Automation, like Real-time Spontaneous Interactions, was a non-cyclical process. However, similarly to the application of Phasing LFO Processes, it was used to create gradual change. In this way, this process was ideal to generate linear development with only micro changes to timbre and texture from cell cycle to the next, enabling repetition to maintain its effects.

Real-time Performance, Phasing LFO Process and Incremental Parameter Automation were applied through different stages of a three-step cyclical process: Programming; where cells, instruments and LFO processes were designed; Improvisation; where Real-time Spontaneous Performances were made and Editing: where productions were distilled, and Incremental Parameter Automations were added. This would lead back to re-programming, new improvisations and further editing. The application of these three processes through each production can be observed through the Production Analyses Tables of Appendix 1. Additional research into the further integration of these three processes, particularly of all processes within single instruments would look to further extend applications of variation and linear development to repeating cells within productions.

By sharing the same conceptual framework, synchronisation between sound and vision was sought through a connection between the two media. Use of real-world imagery, of either ultra-fast time-lapse or super-slow-motion footage, used repeating video cells to both explore relationships with temporal time experiences, as well as human or 'real-world' interactions with autonomous mechanical processes.
Phasing LFO Processes, a concept utilised throughout the audio production, were created in the audio-visual work through the use of composite video cells, repeating at slightly different lengths. This saw the creation of development over time, as the phasing between cells increased and the audio-visual image moved from tangible to abstract.

To enable synchronisation between the audio and audio-visual media, video cell speeds were adjusted so that the length of a video repetition was equal to the length of an audio phrase. The density of composited video cells was changed to represent the density of audio. Effects were added both gradually and incrementally to express development over time but were also triggered in an instantaneous way to synchronise with changes in form. Audio-visual production integrated with the editing process of audio production but was more representative, rather than integrated with the processes of real-time interaction and programming of cell and instrument design.

Further research here would experiment to find different results by changing the order or production process. The audio software Ableton Live was used to control the vision software Touch Designer, what if this process was reversed? Methods to find suitable

integration of improvisation into Touch Designer, while not found in this research, may be found through the changing of production process order or a more integrated approach such that the audio and audio-visual are created simultaneously. Alternatively, production processes of audio that seek to be representative of the audio-visual component, rather than integrated, may create interesting results.

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Appendix 1

Production Arrangement, Production Breakdown and Analyses Tables

Xylo – 5:54 – 4/4 – 122 bpm

Notable Features

- Primary melodic cell on the instrument track *Melody Drone* contains 2 notes played in an 8-bar repeating cell
- Little timbral variance found in percussion parts
- Rhythmic density created in percussion parts through Real Time Spontaneous Parameter Interactions with tracks sends to Return Tracks containing Delay and Reverb sends
- Polyrhythms created by sending instruments tracks to a Return Track containing a dotted 1/8th note delay
- Variance to *Iso Lunar* and *Melody Drone* tracks timbre created through the combination of assigning Phasing LFO controllers to instrument parameters, in combination with Incremental Parameter Controls to build and density over time.

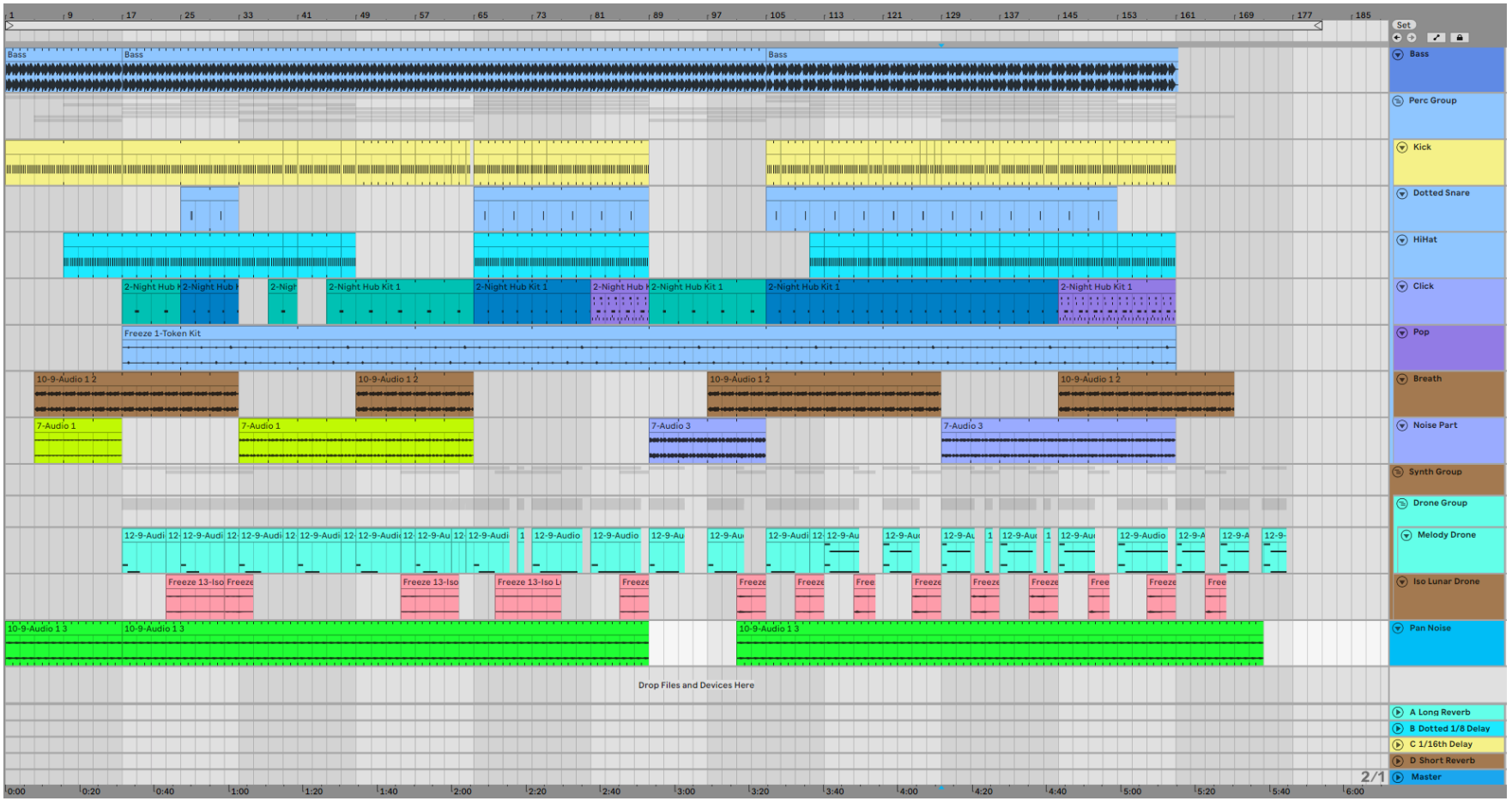

Fig. 7.01 – Ableton arrangement view of *Xylo*, displaying all eleven instrument tracks and four return tracks

Table 7 - Xylo - Production Breakdown and Analysis

Track Name	Cell Type	Cell Length	Phasing LFO Processes	Real-Time Spontaneous Parameter Interactions	Incremental Parameter Automation
12. Bass	Bass	1 bar	-	-	-
13. Kick	Percussion	1 bar	-	-	-
14. Hi-Hat	Percussion	1 bar	-	- Send volume to Return Track C to create shaker effect, bar 111-161 (Fig. 3)	- Increase in send volume to Return Track C, bar 41-49, 85-89
15. Dotted Snare	Percussion	2 bars – dotted 1/8 note delay	-	-	-
16. Click	Percussion	1 note every 1, 2 or 4 bars	-	Send to Return Track B, bar 123-145	-
17. Pop	Percussion	1 note every 2 bars	-	-	-
18. Breath	Percussion	2 bars	-	-	-
19. Noise	Percussion	2 bars	- Panning at 0.09 Hz	-	-
20. Melody Drone	Melody	8 bars	- Attack time at 0.08 Hz - Send to Return Track A at a period of 9 bars (17.7 seconds), bar 33-105 (Fig. 2)	Notes recorded in real time	- Send to Return Track C, bar 121-173 - Send to Return Track A, bar 113-181 (Fig. 2)
21. Iso Lunar	Drone	8 bars	- Filter Cut-off 0.07 Hz - Wave Position at 0.04 Hz - Iso Lunar reverb decay time between 2-5 seconds at 0.09 Hz - Iso Lunar reverb wet/dry control at 0.09 Hz - Phaser FX at 0.13 Hz (Fig. 1)	-	- Panning on each note gradually moves from left to right or right to left every 8 bars - Increase in send to Return Track B, bar 113-161
22. Pan Noise	Ambience	1 bar	- Phaser and Panning FX at 0.02	-	- Send volume to Return Track B, bar 139-166,
Return Track A	Long Reverb	n/a	-	-	-
Return Track B	Dotted 1/8th Note Delay	n/a	- Filter modulation at 0.04 Hz	-	-
Return Track C	1/16th Note Delay	n/a	-	-	- Alteration to feedback time at bar 45-53, 85-93
Return Track D	Short Reverb	n/a	-	-	-

Cambodia – 6:35 – 4/4 – 122 bpm

Notable Features

- Primary melodic cell of instrument tracks *Kontakt Piano* and *8ve Piano* contain a sequence of six 1/8th notes and is three beats long
- This cell is strongly polyrhythmic, playing against 4/4 time in the percussion instrument tracks
- Little timbral variation in percussion and bass instrument tracks
- Lots of timbral and spatial variation created through Real-time Spontaneous Parameter Interactions controlling send volumes of instrument tracks *Kontakt Piano*, *8ve Piano* and *MKorg Audio* to return tracks containing reverb and dotted ¼ note delays

Fig. 7.02 – Ableton arrangement view of Cambodia displaying all 12 tracks and 4 return tracks

Table 8 - Cambodia - Production Breakdown and Analysis

Track Name	Cell Type	Cell Length	Phasing LFO Processes	Real-Time Spontaneous Parameter Interactions	Incremental Parameter Automation
13. Mopho Audio	Bass	1 bar	-	-	-
14. Kick	Percussion	1 bar	-	-	-
15. Hi Hat	Percussion	1 bar	-	Decay time bar 67-73, bar 151-162	Decay time bar 141-153
16. Ride	Percussion	1 beat – single and doubled part	-	-	Volume on track ¼ note Delay FX bar 68-73, bar 157-161
17. Glitch Loop	Percussion	2 bars	-	-	-
18. Circuit Loop	Percussion	4 bars	-	-	-
19. Click	Percussion	1 bar	-	-	-
20. Click2	Percussion	2 bars	-	-	-
21. Shaker	Percussion	2 bars	-	-	-
22. Kontakt Piano	Melody	3 beats	- Phaser FX applied in Kontakt Piano instrument. Exact speed unable to be determined.	- Note length (Tremolator Depth) - 1/8th note to 16th note transitions (Tremolator Width) - Low Pass Filter Frequency - Send to Return A: Dotted ¼ Note Delay - Send to Return B: Dotted ¼ Note Ping-Pong Delay (See Fig.6)	- Track volume - Low Pass Filter Frequency - Send to Return A: Dotted ¼ Note Delay - Send to Return B: Dotted ¼ Note Ping-Pong Delay (See Fig.6)
23. 8ve Piano	Melody	3 beats (same cell as Kontakt Piano displaced by 2 beats, see Fig. 7a and 7b)	- Phaser FX applied in Kontakt Piano instrument. Exact speed unable to be determined.	- Copy and paste of data created in the cell above	- Copy and paste of data created in the cell above
24. MKorg Audio	Pad	8 bars	- Phaser FX applied in the MikroKorg hardware synthesiser. Exact speed unable to be determined.	- Performance using MicroKorg LPF filter frequency	- Track Volume - Depth amount to ¼ note volume ducking applied using Tremolator FX from bar 90-98
Return Track A	Dotted ¼ Note Delay	n/a	-	-	- Delay Feedback at bar 81-85
Return Track B	Dotted ¼ Ping-Pong Delay/Reverb	n/a	-	-	-
Return Track C	Slap Echo	n/a	-	-	-
Return Track D	Short Reverb	n/a	-	-	-

Melting – 5:38 – 4/4 – 122 bpm

Notable Features

- No real time performance interactions other than the deploying and cessation of instrument track cells
- Only six instruments used
- Extensive use of Phasing LFO Parameters and Incremental Parameter Automation but on different instrument tracks
- Polyrhythmic effects created only through sends to a ¼ note dotted delay return track but play a minor part throughout

Fig. 7.03 – Ableton Arrangement view of all six tracks and six return tracks of Melting

Table 9 - Melting - Production Breakdown and Analysis

Track Name	Cell Type	Cell Length	Phasing LFO Processes	Real-Time Spontaneous Parameter Interactions	Incremental Parameter Automation
1. Face Melt Kit	Kick and Bass	1 bar	- Track Delay Dotted 1/8th contains filter modulated at 0.5 Hz	-	- Changes to LPF frequency throughout - Changes to Overdrive amount throughout - Track Delay Dotted 1/8th note activated at Bar 41, 60, 82, 140
2. Operator	Drone/Melody	Non-repeating	- Pitch of Oscillators A, B, C, D assigned to a Sine LFO at 2 (of scale 0-127, approx. 0.03 Hz) - Osc. B Vol assigned to LFO at 0.06 Hz - Send volume to Return Track C: ¼ Reverse Delay assigned to LFO at 0.05 Hz - Filter frequency Bite Distortion assigned to LFO at 0.07 Hz	-	- Changes to Oscillator D volume of the Operator FM synth throughout - Changes to Tremolator depth, operating a ½ note volume envelope throughout - Send to Return Track B: 1/8th Delay at Bars 49-61, 129-140, 149-165
3. Electro Cymbal Loop	Percussion	1 beat	-	-	-
4. Weird Perc Loop	Percussion	1 beat	- Volume of track assigned to an LFO at 9 bars	-	-
5. Hi Hat	Percussion	1 beat	- Pitch assigned to LFO at 0.03 Hz - Send volume to Return Track B: 1/8th Delay assigned to LFO at 0.09 Hz	-	- Send volume to Return Track D: ¼ Dotted Delay at Bar 133-141
6. Diva	Rhythmic Drone	2 bars	- Filter cut-off assigned to LFO at 10 seconds	-	-
Return Track A	Long Reverb	n/a	-	-	-
Return Track B	1/8th Note Delay	n/a	-	-	-
Return Track C	¼ Note Reverse Delay/Bit Distortion	n/a	- Crunch of Bit Distortion assigned to LFO at 0.03 Hz	-	-
Return Track D	Dotted ¼ Note Delay	n/a	-	-	-
Return Track E	Short Reverb	n/a	-	-	-
Return Track F	½ Note Delay	n/a	-	-	-

Shadow Boxing – 6:10 – 4/4 – 124 bpm

Notable Features

- Real-time Spontaneous Parameter Interactions used extensively on the melodic instrument track *Piano* but are not used elsewhere
- The cell on the instrument track *Piano* is the only melodic content; a 4-bar cell of a single minor chord sampled and programmed at 3 different pitches
- Few polyrhythmic elements throughout, with only the *Ride* instrument track containing a 3:2 polyrhythm
- Phasing LFOs applied extensively to Drone and Ambient tracks to create non-repeating timbral movement
- Incremental Parameter Automation used on volume sends of percussion instrument tracks to return tracks containing ¼ and 1/8th note delays
- No variation to low end Bass and Kick instrument track cells

Fig. 7.04 - Ableton arrangement view of all twelve tracks and five return tracks of Shadow Boxing

Table 10 - Shadow Boxing - Production Breakdown and Analysis

Track Name	Cell Type	Cell Length	Phasing LFO Processes	Real-Time Spontaneous Parameter Interactions	Incremental Parameter Automation
1. Bass	Bass	1 bar	-	-	-
2. Kick	Percussion	1 beat	-	-	-
3. Hi Hat	Percussion	1 beat	-		Send volume to Return Tracks B and D at Bars 45-57, 121-129, 145-169
4. Rim	Percussion	2 bars	-	-	-
5. Ride	Percussion	3 1/8th notes	- 2 beat volume envelope	-	-
6. 727 Toms	Percussion	1 bar	-	-	-
7. Shaker	Percussion	1 beat	-	-	Send volume to Return Track D at Bars 113-129, 153-169
8. Crash Build	Percussion	Non-repeating	-	-	-
9. Piano	Melodic	4 bars	-	Send volume to Return Tracks A, B, C and D throughout (See Fig. 13)	-
10. Strings	Drone	Non-repeating	- Filter cut-off assigned to LFO at 10 seconds	-	Volume automated throughout to create crescendos throughout
11. Sweep Pad	Drone	Non-repeating	- Frequency modulation assigned to LFO at 0.4 Hz - Ring Modulation Frequency assigned to LFO at 0.06 Hz (See Fig. 12)	-	-
12. Water FX	Ambience	9 bars	- Panning assigned to LFO at 0.05 Hz - Pitch and filter assigned to LFO at 0.03 Hz (See Fig. 14)	-	-
Return Track A:	Long Reverb		Filter modulation at 0.50 Hz	-	-
Return Track B:	¼ Note Filter Delay		-	-	Delay Feedback increases at Bars 105-113
Return Track C:	¼ Note Ping-Pong Delay		-	-	Delay Feedback increases at Bars 105-113, 169-187
Return Track D:	1/8th Note Reverse Delay		Phaser FX added at 0.2 Hz	-	-
Return Track E:	Short Reverb		-	-	-

Notable Features

- Few Real-time Spontaneous Parameter Interactions controlling timbre or spatial effects
- Principle melody is a 2-bar cell containing a sample of a single gamelan note at 3 different pitches, alternating octaves throughout the track
- No polyrhythms programmed into percussion or melody tracks. Little polyrhythmic information in the delay times in Return Track effects
- LFOs predominantly used to create modulation to the filter on the of the delay and reverb effects of the Return Tracks
- Incremental Parameter Automation used as the principle way of creating variation to timbre and spatial effects from the *Melody* instrument track

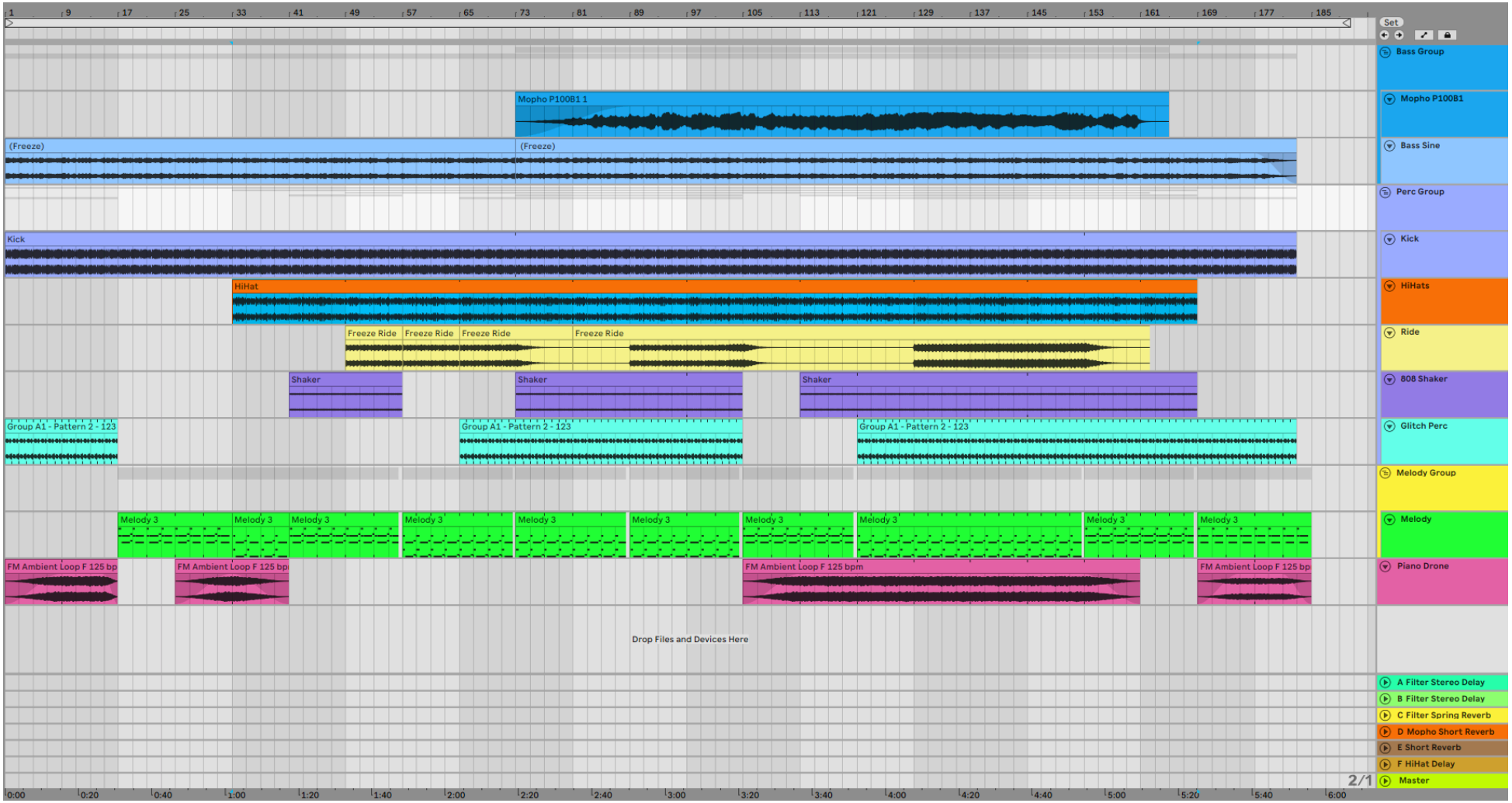

Fig. 7.05 – Ableton arrangement view of Gamelan's nine tracks and six return tracks

Table 11 - Gamelan - Production Breakdown and Analysis

Track Name	Cell Type	Cell Length	Phasing LFO Processes	Real-Time Spontaneous Parameter Interactions	Incremental Parameter Automation
10. Mopho P100B1	Drone	Non-repeating	-	- Real time performance utilising filter and feedback parameters on Mopho hardware synth	- Send volume to Return Tracks B, C and D. Envelope copied and pasted for effect to be replicated across 3 different returns, with subtle adjustments. From bar 73-163. (Fig. 16)
11. Bass Sine	Bass	2 beat	-	-	-
12. Kick	Percussion	1 bar	-	-	-
13. Hi Hats	Percussion	1 bar	-	-	- Send volume to Return Track F from bar 121-153
14. Ride	Percussion	1 beat	-	- Ride decay performed from bar 121-155	- Instrument echo increased from bar 101-105, 157 to 161 - Track panning from 105- 109, 161-165
15. 808 Shaker	Percussion	2 beat	-	-	-
16. Glitch Perc	Percussion	1 bar	-	-	-
17. Melody	Melody	2 bars, played in alternating 8ves	-	-	- Instrument decay gradually increasing from bar 17-185 - Send volume to Return Tracks A, B, C and E (through Melody Group track) - Instrument volume increasing from bar 129-153
18. Piano Drone	Drone	8 bars	Filter modulation at 0.53 Hz	-	- Volume fade in and out - Send volume to Return Tracks A, B and C
Return Track A: Filter Stereo Delay A	Filtered Stereo dotted ¼ note (left) and ¼ note (right) delay	n/a	Frequency modulation at 0.04 Hz	-	-
Return Track B: Filter Stereo Delay B	Stereo ¼ note (left) and 1/8th (right) delay	n/a	Frequency modulation at 0.03 Hz	-	-
Return Track C: Filter Spring Reverb	Filtered spring reverb	n/a	Frequency modulation at 0.07 Hz	-	-
Return Track D: Mopho Short Reverb	Short reflections for Mopho track	n/a	-	-	-
Return Track E: Short Reverb	Short reflections	n/a	-	-	-
Return Track F: Hi Hat Delay	1/8th note delay	n/a	Frequency modulation at 0.11 Hz	-	-

RBSO – 7:14 – 4/4 – 124 bpm

Notable Features

- Real-time Spontaneous Parameter Interactions undertaken across three instrument tracks: *Mopho Bass p68 B1*, *Indie Roll* and *Reaktor6*
- Phasing sequences of lengths 16, 3 and 5 1/16th notes used in the Mopho instrument track
- Single melody cells found on the instrument tracks *Indie Roll* and *Reaktor6*
- Complex polyrhythms used in *Mopho* and melody parts, offset by rhythmically simple percussion parts
- Incremental Parameter Automation used to create development, predominantly by increasing send volumes to return tracks

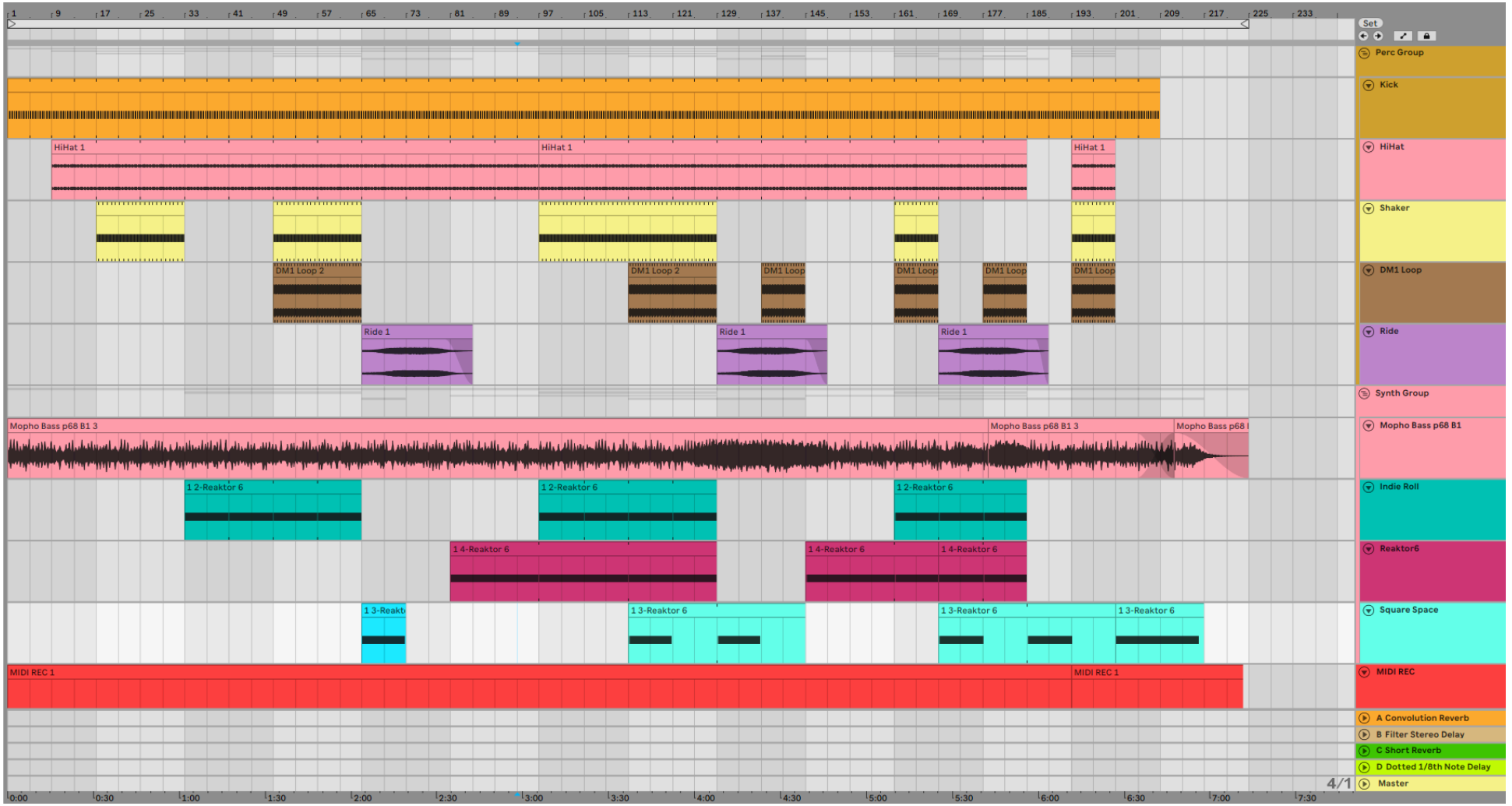

Fig. 7.06 – Ableton arrangement view of RBSO showing 9 tracks and 4 returns

Table 12 - RBSO - Production Breakdown and Analysis

Track Name	Cell Type	Cell Length	Phasing LFO Processes	Real-Time Spontaneous Parameter Interactions	Incremental Parameter Automation
1. Kick	Percussion	1 bar	-	-	-
2. Hi Hat	Percussion	1 bar	-	-	-
3. Shaker	Percussion	1 bar	-	-	-
4. DM1 Loop	Percussion	2 beats	- Filter modulation at 0.03 Hz		- Adjustment to filter cut-off throughout - Adjustment to send volume to Return Track B
5. Ride	Percussion	1 beat	-	-	- Adjustment to stereo width effect - Adjustment to Return Tracks A, B and D
6. Mopho Bass	Bass	1 bar	- Modulated by sequences three 1/16th and five 1/16th notes in length (See Fig. 21)	- Adjustment to Mopho hardware amp release, noise and cut-off frequency (recorded as MIDI see Fig. 20)	- Send volume to Return Track D from bar 209-255
7. Indie Roll	Melody	1 bar	-	- Adjustment to send volume to Return Track B - Adjustment to instrument decay (see Fig. 22)	- Send volume to Return Track B
8. Reaktor6	Melody	Nine 1/16th Notes	- LFO at 0.36 Hz controlling filter cut-off	- Adjustment to Oscillator Mix - Adjustment to FM synthesis	- Send volume to Return Track D from bar 125-129, 181-185
9. Square Space	Drone	Non-repeating	-	-	- Adjustments to filter cut-off
Return Track A	Long Reverb	n/a	-	-	-
Return Track B	Filtered Stereo Delay; 1/8th note (left) and dotted 1/8th note (right)	n/a	- Filter modulation at 0.02 Hz	-	Increase to delay feedback at bar 64-73, 127-143, 183-205
Return Track C	Short Reverb	n/a	-	-	-
Return Track D	Dotted 1/8th Note Delay	n/a	-	-	Increase to delay feedback at bar 57-69, 121-133, 141-147, 177-193

Notable Features

- Real-time Spontaneous Parameter Interactions work in tandem with Incremental Parameter Automation in instrument tracks such *Bass* and *3/16th*
- Primary melodic content contained in a polyrhythmic cell of a single note, created using a short envelope filter in Tremolator over what was originally a single note synth drone
- Envelope filter plays continuously every three 1/16th notes, creating a prominent polyrhythmic effect
- LFOs used to modulate filters on delays and reverbs on the Return Tracks, as well as in the *MicroKorg B36* instrument track

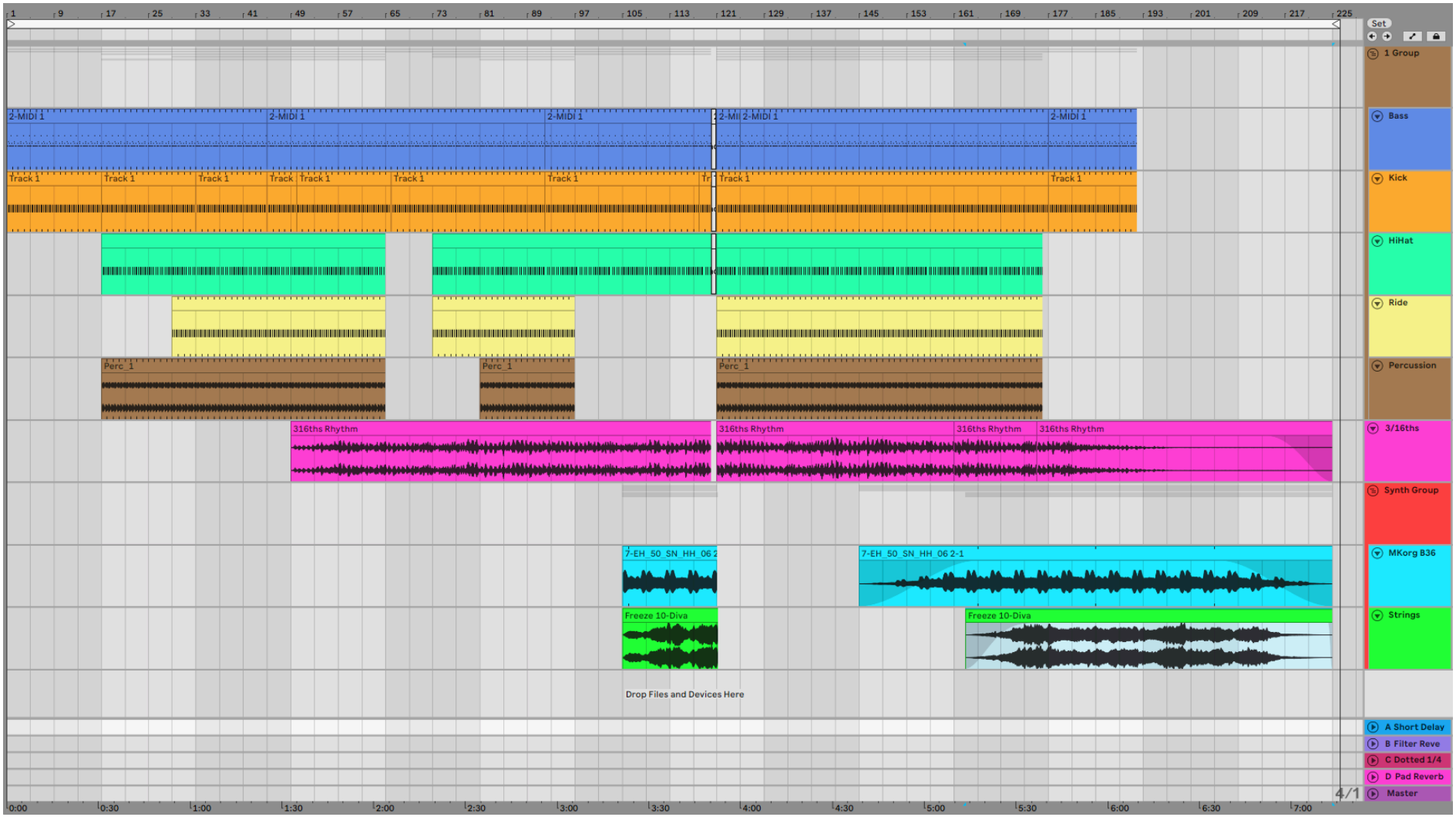

Fig. 7.07 – Ableton arrangement view of SS2TO, displaying 8 tracks and 4 Return Tracks

Table 13 - SS2TO - Production Breakdown and Analysis

Track Name	Cell Type	Cell Length	Phasing LFO Processes	Real-Time Spontaneous Parameter Interactions	Incremental Parameter Automation
1. Bass	Bass	2 beats	-	- Instrument attack, bar 1-87 - Filter frequency, bar1-87 - Filter resonance, bar 1-87 (Fig. 25)	- Adjustments to filter frequency, bar 87-193 (Fig. 25)
2. Kick	Percussion	1 bar	-	-	-
3. Hi Hat	Percussion	1 bar	-	-	- Send volume to Return Track C, bars 61-65, 93-97, 169-176
4. Ride	Percussion	1 bar	-	-	- Adjustments to ride cymbal decay, bars 49-65, 85-97, 125-176 - Volume fade in, bars 29-33, 73-81 - Send volume to Return Track C, bars 61-65, 93-97
5. Percussion	Percussion	1 bar	-	-	-
6. 3/16ths	Melody	3 16th notes	-	- Send to instrument delay throughout	- Send volume to Return Tracks B, C and D throughout (Fig. 26)
7. MKorg B36	Chords	4 bars	Phaser and pan effect at 0.05 Hz	- MicroKorg keyboard played live in a real time performance for 20 bars, which is looped	- Send volume on Synth Group to Return Tracks B, C and D
8. Strings	Drone	4 bars	Filter cut-off at 10 seconds	-	- See above for Synth Group
Return Track A	Short Delay	n/a	-	-	-
Return Track B	Filtered Reverb	n/a	Filter modulation at 0.03 Hz	-	-
Return Track C	Filtered Dotted ¼ Note Ping-Pong Delay	n/a	Filter modulation at 0.07 Hz Tremolator Depth assigned to LFO at 0.06 Hz	-	-
Return Track D	Pad Reverb	n/a	-	-	-