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An Approach to Composition Based on a Minimal Techno Case Study

by

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Submitted for the degree of Doctor of Philosophy

Department of Music, Humanities and Media

University of Huddersfield

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Abstract

This dissertation examines key issues relating to minimal techno, a sub-genre of electronic dance music (EDM) that emerged in the early 1990s. These key issues are the aesthetics, composition, performance, and technology of minimal techno, as well as the economics of EDM production. The study aims to answer the following question. What is the musical and social significance of minimal techno production and performance?

The study is conducted in two parts. The history of minimal music is traced from Satie in the 1890s to Plastikman in the 1990s, a central contribution to minimal techno. Plastikman is a stage name for the subject of the first part, a case study of minimal techno artist Richie Hawtin. A chapter on Liine, a company I founded with partners including Richie Hawtin, describes the performance software we developed for his 2010-2011 Plastikman Live tour. A chapter on minimal techno performance methods examines the structure of the Ableton Live set created for Plastikman Live. A theory chapter, based on Jacques Attali's *Bruits* (2001), studies the relationship between technology, money, power and techno music production on both an individual and collective scale. The second part provides a detailed commentary on music I composed during the project in response to the theoretical issues raised. A final chapter discusses the overall thesis, and draws conclusions.

Minimal techno, as it is practiced through Liine software, the Plastikman Live show, or through my own productions, is revealed to be a deeply improvisatory form of music. The relationship between body, mind and sound emerges as one of the major themes. Minimal techno production and performance can be seen as a reflection of the profoundly changing relationship between man and digital technology.

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Without the collaboration of Richie Hawtin, this dissertation would simply not have been possible. I thank him for his impeccable professionalism, keen mentorship, valued partnership, and for the unparalleled access to his time and to Plastikman Live materials.

I am grateful to the following companies for providing software licenses: Ableton, AudioRealism, Cycling 74, D16, Lexicon, PSP Audioware, SoundToys. Screenshots of Live and MaxMSP used with permission from Ableton and Cycling 74.

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Introduction

Electronic Dance Music (EDM) and the related Electronic Music Dance Culture (EDMC) have been developing since the late 1970s. Minimal techno, a sub-genre of EDM, has gained worldwide popularity since the 1990s. Minimal techno events are now held in stadium-sized venues, and this is the first substantial academic study of this musical and cultural form. This thesis aims to demonstrate, by way of a case study, how minimal techno music is created, performed, and why that is significant in the 21st century. What is the musical and social significance of minimal techno production and performance?

The study is structured in five chapters that, together, address a number of secondary questions. What is minimal techno? What are its principal musical characteristics? How can minimal techno be produced? How can minimal techno be performed? Why make minimal techno? What is the relationship between minimal techno and technology? What are some of the potential relationships between money and minimal techno production?

A background chapter includes a literature review, a methodology section and a brief history of minimal music. Literature dealing with music theory, composition and production receives a particular emphasis. The primary research method used for this dissertation, participant observation, is discussed, as are the reasons for its use. The history of minimal music is traced from Satie in the 1890s to Plastikman's early works

from the 1990s, a central contribution to minimal techno. Plastikman is a stage for minimal techno artist Richie Hawtin.

A chapter on performance technology focuses on software initially created by the software company Liine for the Plastikman Live show and later released as commercial products. Liine was founded in April 2010 by myself, Richie Hawtin, John Acquaviva, Etienne Noreau-Hébert, Mark Quail and Gareth Williams. Since then we have released over a dozen apps in the iTunes App Store, including the iPad version of the JazzMutant Lemur. I went on tour several times in 2012 with Hawtin for the Plastikman Live show. Through my work at Liine I am in close contact with music technology companies such as Beatport, SoundCloud, Ableton and Native Instruments. I have worked on custom performance setups with well known EDM live acts and DJs such as Orbital, Carl Craig and Daniel Miller. I experienced the Berlin EDM and music technology scene from a unique insider perspective.

A chapter on minimal techno musical structures examines, as a case study, the Ableton Live set created for Plastikman Live. The overall structure is explained in detail and is accompanied by supporting graphs and tables. A single track, 'Plasticine', is analysed in detail. A theory chapter is based on Jacques Attali's *Bruits* (2001), and studies the relationships between technology, money, power and techno production on both an individual and collective scale.

The penultimate chapter provides a detailed technical commentary on music that was composed as practice based research written in response to the theoretical concepts under consideration. A final chapter discusses the overall thesis, and draws conclusions.

Minimal techno, as it is practiced through Liine software, the Plastikman Live show, or through my own productions, is revealed to be a deeply improvisatory form of music. The relationship between body, mind and sound emerges as one of the major themes. Minimal techno production and performance can be seen as a reflection of the profoundly changing relationship between man and digital technology.

0. Background

0.1 Literature Review

Much has already been written about Electronic Dance Music (EDM) and Electronic Dance Music Culture (EDMC). Thornton's *Club Cultures* (1995) is a significant work in this field. The author analyses the social structures of EDM events both from her own point of view of as an outsider and from the point of view of insiders she came to know through her research. One of the most significant aspects of her analysis is the application of subcultural capital theory to EDMC, which brings a better understanding to some of the motivations driving actors in EDMC. In a similar vein, Rapp (2010) gives as much attention to people working in the scene as people attending parties in *Lost and Sound: Berlin, Techno and the Easyjet Set*, an overview of the Berlin scene. Rapp provides a useful, somewhat journalistic, overview of the Berlin EDMC industry. The approach is similar in Rietveld's *This is Our House* (1998). These three books, together, provide an overview of the principal roles in EDMC: dancers/audience, promoters/industry and DJs/artists. A complete EDM bibliography is available online on the Dancecult.net, the electronic dance music culture research network. This site also hosts Dancecult: Journal of Electronic Dance Music Culture, the only academic journal currently dedicated to EDM research.

Much has also been written about the history of techno, the EDM sub-genre that is the focus of this study. Authors such as Sicko (1999) in *Techno Rebels* or Shapiro (2000) in *Modulations* are quick to make the distinction between the different meanings of the term 'techno'. At times it is used to identify a sub-genre of EDM associated with Detroit. At other times, the term is used interchangeably with EDM. The early history of techno is particularly well covered, by the aforementioned authors and many others such as May (2007) and Halstead (2010). The literature thins out in recent years, especially for the 2000s and 2010s. In his article *Digital Discipline: Minimalism in House and Techno*, Sherburne (2004) proposes a nomenclature for minimal techno in the early 2000s. The present dissertation focuses on the minimal techno music made by Richie Hawtin under the name Plastikman from the early 1990s, as well as its live performance in the early 2010s.

Literature dealing with other forms of minimal music, addressing different periods and composers, is plentiful, for example Mertens (1980) or Strickland (1993). However, unlike those texts, this project places the meaning of minimalism in Western music in the context of a continuous phenomenon beginning with Satie, suggesting a continuous chain of aesthetics that leads up to early minimal techno. A key text for this task is *American Minimal Music* by Wim Mertens (1980), in which the author presents a detailed study of each the four key figures in classical minimalism: Reich, Glass, Riley and Young. In addition, Mertens examines possible meanings of musical minimalism and debates whether or not the music is teleological. As these issues are linked to ideas from Cage, Stockhausen and Schoenberg, Mertens' analysis provides a useful

framework for understanding minimalism before and up to classical minimalism. The book written by Steve Reich (2002), *Writings on Music 1965-2000*, also provides insights on the evolution and meaning of minimalism. Gann (2004) attempts to provide a definition of musical minimalism. Various texts such as Toltz (2011), Rietveld (2011) and McClary (2004) have sufficiently detailed classical minimalism and its links to krautrock, disco, house and techno, and so this will not be discussed here. It is enough to say that they share many common elements.

Most of the small, but growing, body of literature that analyses EDM musicologically uses tools borrowed from traditional music theory, including western classical notation. In a significant text on this topic, *Unlocking the Groove: Rhythm, Meter, and Musical Design in Electronic Dance Music*, by Mark J. Butler (2006), the author proposes analysing electronic music with a very useful framework that takes into account the different time-scales, micro and macro, at which EDM is produced, performed and experienced. Butler does, however, spend an inordinate amount of time on a particular technique, “turning around the beat”, which Butler considers to be a major component of EDM production. Although “turning around the beat” is very real and Butler’s examples are correct, the present research leads me to characterise the technique as somewhat more peripheral than it is presented, and this is certainly the case in minimal techno.

Butler also invokes fragments of European art music, such as Haydn and Mozart, to support notions of polyrhythms in Underworld or Plastikman. Although perhaps useful

for explaining EDM to classical theorists, relying on references to Haydn and Mozart in this context constitutes a far-fetched analysis. The aesthetic distance from Mozart to Jeff Mills is too great to be of use in my research. Butler uses traditional staff notation to transcribe the dance records under analysis, a useful method for addressing, again, a readership of classical theorists. A more appropriate mix of notational approaches is adopted for this project, however, one more representative of the music, including for example the arrangement view typical of Digital Audio Workstations (DAWs) used to write such music. In this format, each voice is represented as a block, whose length corresponds to the duration of the phrase. Tools from electroacoustic analysis, such as spectral analysis or those proposed by Schaeffer (1977) in *Traité des Objets Musicaux*, may also prove to be more appropriate in many cases, as exemplified by Zeiner-Henriksen (2010). Although his methods of analysis are more appropriate for EDM than are Butler's, the scope of Zeiner-Henriksen's work remains much more limited than Butler's. While Butler aims for a comprehensive analysis of the rhythmical structure of EDM as a whole, Zeiner-Henriksen focuses on the single phenomenon of the 4/4 pattern, that is the 'four to the floor' bass drum. The work of both these authors serve as models for my methods of analysis, with the intended scope lying between these two extremes.

Although the roles played by the EDM musician, producer, DJ or live performer, is, in one sense, very well covered in the existing literature, the musician is often analysed strictly on the basis of how he contributes to making the party happen. This role, often qualified as 'shamanic' by authors such as Rietveld (2004) or St. John (2004), is social.

Rietveld (1998) also presents the DJ as a librarian or archivist. Books such as *Last Night a DJ Saved My Life* by Brewster & Broughton (2000), or *DJ Culture* by Poschardt (1998), present records as texts and the DJ as a creator of new texts through the act of mixing. The angle that I seek for my research is from the point of view of the musician, from a craftsman point of view. This focus is supported by a series of articles written by Goldmann (2011), who is also a producer, DJ and live performer. From his insider position, Goldmann discusses the relationship between the quality of EDM composition and finding commercial success. If other research focuses more on the DJ/performer as one role amongst many in a social setting, the present research focuses on the live performance as one professional role a musician can choose, and, in particular, the techno live performance as musical craftsmanship.

In the course of analysing the relationship between music, money, power and technology, the religious aspect of techno culture merits attention. Two key anthologies provide useful frameworks, St. John (2004) *Rave Culture and Religion* and St. John (2010) *The Local Scenes and Global Culture of Psytrance*. The analysis of religious structures in other scenes can be used to draw parallels with those same structures in techno and Plastikman.

An entire chapter of the present thesis is devoted to an analysis of Plastikman, Liine and global techno production as seen through the prism of Jacques Attali's (2001) theories expounded in *Bruits*. In a single study he ties together the overarching relationships between musicians, music, power, money and technology. These issues

are central to projects such as Plastikman and Liine, as they are both active on the global level of the techno scene.

0.2 Methodology

Participant

EDM scenes comprise a myriad of roles. Existing literature has tended to focus on reception theory and the audience as participant. The participant in this study, however, is the musician specialising in EDM, and more specifically in a dual role of producer and DJ/performer. The producer of EDM typically assumes responsibility for the entire chain of creation of a recording, with the possible exception of the mastering stage, which is often entrusted to a dedicated mastering studio. The EDM producer thus plays the role of composer, arranger, performer and programmer, in addition to recording engineer and project supervision, a far cry from traditional studio productions with live musicians. Similarly, the EDM live performer manipulates studio equipment on stages, unlike the traditional live musician who plays an acoustic or electric instrument. Existing literature, as exemplified by Butler (2006), Rietveld (1998) and Thornton (1995), has focused on participants in local scenes, while this thesis focuses on one participant, Richie Hawtin and his Plastikman project, who for nearly two decades has played a leading role in the global techno scene.

Author's Background

At the time that I am writing this thesis, I am also producing EDM and developing music technology. I have been producing EDM since the late 1990s under various pseudonyms in different styles, and have completed studies in Electroacoustic Composition at the Montreal Music Conservatory. In 2010, I helped found the software company Liine. Before then, I worked as a freelance programmer for projects such as live music performance tools, contemporary dance and interactive installations, and also as a freelance composer and sound designer for video games and various art projects.

In 2006, after completing my electroacoustic studies, I began travelling regularly to Berlin. Between travels, in 2008-2009, I ran a short-lived digital label called Greynoise Recordings as an experiment in self-distribution. The music was distributed on Beatport but also available directly from my website through a custom PayPal system. During this same period, I also released over a dozen tracks on Beatport for various labels such as Josh Gabriel's Different Pieces and John Acquaviva's Definitive Records, as further exercises in digital music distribution.

In 2009, for my own music performance needs, I developed an Ableton Live controller on the JazzMutant Lemur hardware platform. This landed me a job with JazzMutant, thanks to Gareth Williams, whom I had the good fortune to meet in Berlin that same year. In collaboration with Williams and a small team at JazzMutant, we further developed the controller and released it under the name 'Mu'. The release of Mu, in turn, led directly to an association with Richie Hawtin for his Plastikman Live tour.

This new professional association culminated in the foundation of Liine by myself, Richie Hawtin, John Acquaviva, Etienne Noreau-Hébert, Mark Quail and Gareth Williams. Liine develops high-level music controllers on the iPad platform, many of which were initially created for the Plastikman Live tour. Liine's product line also includes Lemur since December 2011.

I travelled with Hawtin as part of the Plastikman Live crew for two of the early shows, in Mannheim for the Timewarp 2010 festival and Barcelona for the Sonar 2010 festival. These were work-intensive trips where we fine-tuned the custom performance systems in the days prior to the actual events. The events themselves were the first of many where I socialised backstage with other industry players such as artists, DJs, label managers and promoters. At Timewarp 2010 I shared backstage banter and after-party drinks with Sven Väth, the “embodiment of German EDM's evolution through the eighties and nineties” (Brewster & Broughton 2005, p. 368). Over the years I became acquainted with many of the Minus artists such as Magda, Ambivalent and Marc Houle. Liine worked with Orbital, an EDM act which gained commercial and critical success in the 1990s (Sicko 1999, p. 77), to build a custom performance setup for their 2012 tour. I have had coffee with Daniel Miller, founder of Mute Records, and had Skype conversations with Carl Craig, a second-wave Detroit DJ and producer (Sicko 1999, p. 72). In Berlin I spent many weekends partying and socialising with colleagues at clubs such as Watergate and Berghain. I am friends with one of the bouncers at Berghain, a relationship that has often guaranteed me passage through the notoriously difficult door (Michael 2010).

Author's Position

This research has been conducted from an insider's position. Not only am I involved in EDMC as an EDM producer, but I am also actively shaping the scene, particularly as it concerns producers and performers, by creating and commercialising new music-making technology. As an insider, I have the advantage of worldwide access to people and information, and must respect the limits this advantage entails. I am cognisant of the level of trust my colleagues must place in me. I informed my colleagues that I intended to write a doctoral thesis, and all materials relating directly to a colleague or interviewee has been cleared by the person before inclusion. I am cognisant of the importance of protecting trade secrets and business strategies, a consideration vital to the portions of this thesis that deal with commercial applications. I am privy to such knowledge only by virtue of connection with my own company, confidential discussions with other companies, or camaraderie among associates of different companies.

In the course of my time in Berlin, I came to suspect that musicians in global EDM scenes were organised in a pyramid hierarchy. Goldmann's description of the phenomenon, which he calls "categorical morphology" (2011a, para. 15), articulates what I felt intuitively. "After helping to form a first minimal subcategory of techno, Hawtin was recognised as its leader" (2011b, para. 7). The leader at the very top of a category, like Hawtin and techno, tends to be a person who significantly contributed to building the pyramid. Looking back now, entering the third year of my association with Hawtin, running Liine and producing tracks in my spare time, I have come to

understand that I had a clear choice. I could either work my way up the ladder of somebody else's aesthetic category, or I could attempt to create my own aesthetic category. The difficulty I felt making this choice is one of the reasons I have played additional roles besides that of producer. Through these additional roles, my association with Liine and Hawtin, in addition to my role as a producer, my position is thus mainly one of participant observation.

As Chernoff (1981) observes in *African Rhythm and African Sensibility*, “the most important gap for the participant-observer [...] is not between what he sees and what is there, but between his experience and how he is going to communicate it” (p. 11) The bulk of this thesis attempts to objectively describe and analyse the mechanics of music production and music performance in the context of Plastikman Live and my own work. In addition, I will set out my intellectual interests and predispositions, and the fact that they shape both my subjective experience of producing EDM in a global scene, and the analytical angles I choose to pursue. I will also attempt to convey this experience through personal accounts of how I contributed to bringing Plastikman Live to stage, helped create Liine, released software and produced my own music.

Several approaches are used in this study. I have analysed portions of the score from Plastikman Live, as well as my own productions, from the angle of music theory, analysis and composition, relying on Moore's *Analysing Popular Music* (2006), Butler (2006) and Zeiner-Henriksen (2010) as starting points for music analysis. I have analysed Liine technology, used as performance tools in the same show, from the

angle of music technology and performance practice. I have conducted a theoretical discussion of the issues surrounding global techno production from the perspective of economics and politics, based on Jacques Attali's *Bruits* (2001). Finally, a core component of my research is based on a significant interview granted to me by Hawtin, as well as personal insights garnered after years of close work with the artist.

This study was conducted with a balance of emic and etic approaches (Harris 1976). As a producer and musician living in Berlin, developing and using performance software, I experience EDM production and performance first-hand. This position corresponds to what Chernoff describes as a “participant-observer” (1981, p. 11). The emic approach is used to describe the “behaviour stream” (Harris 1976, p. 330), that is the material and observable phenomenon of the performance technology, performance methods and commercial mechanisms associated with EDM.

0.3 Minimal Music History

Overview

This section intends to draw a brief history of minimalism, from its early pioneers up to minimal techno. A coherent lineage is drawn through Erik Satie, John Cage, LaMonte Young, Terry Riley, Steve Reich, Philip Glass, Kraftwerk, Juan Atkins, Derrick May, Kevin Saunderson, Jeff Mills, Robert Hood, Daniel Bell and finally Richie Hawtin. This is a highly selective list. For example, one could also look at the importance of 1970s German acts such as Can, Neu! and Faust, but I shall focus solely on Kraftwerk. One could also look at late 1980s rave music in the UK, acid techno in Belgium or industrial music such as Throbbing Gristle. These scenes and artists, however, are well covered in the existing literature by authors such as Ford (1999) for Throbbing Gristle, Albiez (2010) for Kraftwerk, Brewster & Broughton (2000) for DJ culture or Reynolds (1998) for rave music.

Tracing the history of musical minimalism in Western music begins with the music of Erik Satie, around 1890. From that starting point, the ideas and aesthetics of musical minimalism can be seen to evolve over a century, leading to the ubiquity of repetition in techno, as demonstrated in the music of Plastikman in the early 1990s. Classical minimalism refers specifically to the work of art music composers such as Young, Riley, Reich, Glass, Feldman or Bryars. Minimalism, generally speaking, refers to a broad range of techniques which may involve any or all of the following: audible repetition, a static and floating sense of time, a reduction in the quantity of musical materials, a

sparseness of form, and the use of multiple time signatures and metrical arrangement (Gann 2004).

The notions of repetition and minimalism, while closely linked, are not interchangeable. Structural repetition does not necessarily result in an audible musical phenomenon. For example, the repetition of the chord sequence in Bach's *Chaconne* is never explicitly articulated. The chord sequence serves as a framework for continuous lyrical and textural inventiveness. Also, tone rows in serial music are often strictly repeated but that process is not apparent. Repetition in Webern is purely structural, and, as a testament to the composer's intention, perfectly inaudible. Conversely, musical minimalism is not always repetitive. Young's *Trio for Strings*, as with much of Cage and Feldman's music, is about silence, stasis and ambiance.

Musique concrète in France, early electronic music in Germany, as well as the larger body of work known as tape music make use of mechanical reproduction. Overt repetition, however, held little interest for Schaeffer, Henry and Stockhausen. However, tape loops did become a central mechanism for popular music, as evidenced by studio productions such as The Beatles' *Revolution 9* in the 1960s, and later disco, hip-hop and techno in the 1970s and 1980s.

Western minimal music, including many musicians in the 1890-1990 period, is deeply indebted to musical traditions beyond the realm of Western music, and in particular to Javanese Gamelan, West African drumming, and North Indian classical music. These

traditions organise pitch, melody and rhythm in ways quite different than those of the European classical tradition. The implications of these non-Western structures are quite profound, as they often reflect and reinforce their own way to conceive time and perceive the world. In all cases, the goal-oriented tonal system, for example in an equally tempered I-IV-V-I progression, is displaced. In many cases, goal-oriented tonality is replaced by a sense of timelessness and suspension (Mertens 1980, p. 88). The feeling of a journey depends less on harmonic sequences, and more on development within other musical parameters, such as melody, rhythm and timbre. The manner in which each of the aforementioned non-Western musics influenced the development of minimal music will be briefly touched upon.

Satie

Erik Satie was born in 1866 and, as a young man, took up residence in Paris, where he made friends with many influential artists such as Debussy, Ravel, Milhaud and Picasso. The composers Debussy and Ravel acknowledged Satie's influence on their own music. They championed his music by playing it, and Debussy even orchestrated some of Satie's compositions (Prendergast 2000, pp. 6-8). The influence of Satie on minimalism can be seen in the work of many authors such as Orledge (1998), Prendergast (2000), Mertens (1980) and Thorman (2006).

Some of Satie's well-known works are three short series of piano compositions composed and published in the years around 1890, *Gymnopédies*, *Sarabandes* and *Gnossiennes*. These compositions exhibit many of the traits that define minimalism. For

example, *Gymnopédie no. 1*, starts by alternating G and D major seventh chords, yielding no sense of resolution. Instead, these introductory chords break with the directionality of tonality, instilling a sense of time suspended. The moods pioneered by Satie continued to influence the work of later composers over a half-century later, even if Feldman and Young used very different harmonic materials. The very notation Satie chose is yet another example of minimalism. Satie wrote much of this music without bar lines, as if to convey an open sense of horizontal time unbroken by vertical signposts. Prendergast writes that Satie, like Debussy and Ravel, was influenced by Gamelan music featured at the Paris Exposition of 1889 (2000, pp. 6-14). This encounter with non-Western music might be the source of the synthetic scales in the *Gnossiennes*. One such example, a scale consisting of the E minor and F# major triads, contains intervals considered exotic at the time, such as the augmented second formed between G and A#. Satie was emphasising static development and implicitly proposing a focus on timbre decades before Cage or Eno.

Satie's posthumous work *Vexations*, while somewhat of a radical novelty, is extremely prescient. The score calls for 840 exact repetitions of a simple, angular melody and its subsequent, equally angular, harmonisation. *Vexations* could well have emerged from the Fluxus movement in the 1960s. It was first published in 1949, "thanks to [John] Cage" (Orledge 1998, para. 1), who also organised the well documented 1963 performance at the Pocket Theatre in New York (Bryars 1983, para. 10).

Cage

Cage has been discussed by authors such as Gann (2011) on the topic of silence, Prendergast (2000) on the topic of ambient music or Strickland (1993) on the topic of the origins of minimalism. John Cage was born in 1912 and played a prominent and influential role in 20th century musical thought through his prodigious output and innovations. Of particular relevance to the present study is the interest Cage demonstrated for Satie. Cage acts as a direct link between Satie, whose music he greatly admired, and the American Minimalists, many of who were strongly influenced by Cage. Cage's legacy developed as much in his philosophy, words and personal relationships, such as his friendship with Philip Glass, as it did via his compositions and recordings.

Cage studied with Schoenberg and later corresponded with Boulez. Cage was also deeply enamoured with the music of Satie, which is diametrically opposite to the serialist approach. Cage organised a performance of *Vexations* and championed other Satie works in the 1960s. Cage pays tribute to Satie with the titles of some of his late compositions *Letter to Erik Satie* (1978) and *J. Joyce, M. Duchamp, E. Satie: An Alphabet* (1979).

One of the first non-Western music traditions to which Cage was drawn is Javanese Gamelan. The exotic sonorities of the prepared piano, first premiered in the dance piece *Bacchanale* (1940), alluded to the diverse timbres of Gamelan music. Furthermore, *Bacchanale* makes use of prominent and motoric ostinati. Besides the links to Gamelan patterns, Cage's music forged a path for further evolution by Reich,

Glass and Riley. Cage's piano piece *Dream* (1948) demonstrates a voluntary simplicity. Most of the piece is monophonic and uses simple diatonic patterns, anticipating techniques used in many minimal techno tracks made 50 years later.

Cage is renowned for his use of the I Ching as a method of introducing indeterminacy in composition. The use of chance operations in contemporary EDM production is now so common that it is easy to miss the significance, but its introduction to Western music marks a turning point as significant as the adoption of equal temperament or the invention of recording technologies. Cage felt compelled to push the idea to conceptual extremes, by removing all decision in *Variations 8*, a piece that is no more than a title, or by scoring silence to emphasise ambient sound in *4'33"*. But from then on, indeterminacy took on a more subtle form in music-making. Today, indeterminacy is ubiquitous, as demonstrated by software such as Lemur or Max for Live, or through open forms such as recombinant techno tracks, or through improvised DJ sets. The focus of music on strict performance of printed scores from beginning to end is no longer a dominant format that needs to be challenged.

American Minimalists

La Monte Young, Terry Riley, Steve Reich and Philip Glass, all born between 1935 and 1937, are important composers in the history of 20th century musical minimalism. For the most part, the landmark pieces that defined their musical language were composed in the 1960s and 1970s. Generally speaking, the four composers influenced each other, attended each other's concerts and, at times, played in each others ensembles.

Mertens studies the exact constellation of relationships and interactions in *American Minimal Music* (1980). Each of the four musicians made a significant contribution to the lineage of musical minimalism.

Although Young's early output is characterised by serialism, it was soon to be characterised by ideas of silence and stasis. Mertens writes that in 1960 Young "attended Karlheinz Stockhausen's seminars in Darmstadt and he made an intensive study of John Cage's works" (1980, p. 19). Young was one of the first composers to consciously focus his work primarily on musical minimalism. While the work of Cage and Satie merely alludes to the roots of minimalism, Young's work exhibits a major focus on minimalist techniques. His *String Trio* (1958) is a definitive piece of minimal music in spite of its atonal harmony. Each instrument of the trio plays only a single note. Each note is held for a very long time. The score features long silences. There is no notion of development, whether harmonic or of any other type. The *String Trio* is characteristically minimalist by virtue of its harmonic stasis and its limpid simplicity. Strickland (1993, p. 125) points to Japanese Gagaku music as an influence of "smoothness, serenity, and precise execution". Pieces composed during Young's Fluxus period demonstrate a reduction of sound material. *Composition 1960 #7* specifies simply that a B F# open fifth should be held for a long time. Young's interest in sustained sound took shape once he formed the ensemble The Theatre of Eternal Music. From then on, drones and the harmonic overtones series were central to Young's musical output, and reflected the influence of his study of Indian classical music.

Like Young, Terry Riley was a student of Indian classical musician Pandit Pran Nath. However, as Mertens explains, the influence of Indian music is only partial: “since he [Riley] came to Indian music more by thinking through his own musical ideas. This is partly proved by the fact that he does not rely on a fixed form-scheme, which is an important aspect in Indian improvisatory music” (1983, p. 44). Repetition, a minor aspect of Young’s work, became a central focus for Riley. *In C* (1964) is a quintessential example of repetition based on short melodic cells. The ensemble that premiered the piece included Steve Reich among its performers. The score presents a series of 53 short melodic cells that should be played by a large ensemble. Each musician can repeat a cell as long as he wishes, but without straying too far in the score from the rest of the ensemble. The result is an organic phasing effect through which a harmonic drone emerges.

Steve Reich, born in 1936, was acquainted and, at times, worked with Young, Riley and Glass. Inspired by Riley’s *In C*, Reich’s search for new ways to use repetition led him to experiment with tape loops playing against each other. This technique was formalised in the tape pieces *It’s Gonna Rain* (1965), *Come Out* (1966) and *Melodica* (1966). The phasing technique was first carried over from electroacoustic music to instrumental music in *Piano Phase* (1967), and was last used in *Drumming* (1971). In addition to phasing techniques, *Drumming* is also notable for its adoption of West African music techniques, techniques that Reich studied during a year spent in Ghana. The short canons demonstrated in these early phase pieces evolved into the tempo-synced delay techniques commonly used in contemporary electronic music. Another technique that

defines Reich's early work is one he calls "replacing rests with beats". The technique consists of a pattern that is repeated while notes are slowly added to the pattern.

Reich also experimented with extreme augmentation, as formally exemplified by the piece *Four Organs* (1970). Four keyboard players repeatedly play a short chord in unison. Slowly, on every repetition, the chord is held slightly longer. Repeated over the course of 15 minutes, the process results in a sustained chord. All these techniques, initially explored in raw experimental pieces, were gathered in a long form for the first time in *Music for 18 Musicians* (1976). This composition can be considered to be the conclusion of Reich's experimental period in repetitive techniques. Reich's influence on EDM is explicitly acknowledged in the compilation *Reich Remixed* (1999), where Reich's recordings are remixed by a variety of electronic artists. Reich's piece *Electric Counterpoint* (1987), as recorded by Pat Metheny, was sampled by The Orb on their 1990 track 'Little Fluffy Clouds'. Reich's influence can also be heard in the minimal techno track 'Minus' by Robert Hood (1994). The musical structure of Hood's 'Minus' will be examined further on.

Philip Glass, born in 1937, studied at the Juilliard School of Music in New York and later with Darius Milhaud, among others. Milhaud was a friend and contemporary of Satie earlier in the century. Reich attended Juilliard at the same time as Glass, although the two were not acquainted at the time. Principles of addition borrowed from Indian classical music, as well as formal studies in Western classical music, greatly influenced Glass, as demonstrated in early experimental compositions such as *Music in Twelve*

Parts (1974) and, later, in *Einstein on the Beach* (1976). Glass was first exposed to Indian Classical music through work with Ravi Shankar. Their first collaboration was on a film soundtrack in 1966. They later collaborated on the album *Passages* in 1990. Of the four American Minimalists, Glass was the only one who did not eventually move on to music styles sounding very different from his original motoric tendencies. Glass has generally retained his motoric arpeggios although his harmonic palette has widened. Glass' style has been widely adopted in film music and advertising. His music is explicitly linked to EDM through various projects such as his orchestration of Aphex Twin's 'Icct Hedral' (1995) and the *Glass Cuts* (2005) compilation, where various EDM producers remixed Glass.

Kraftwerk

The band Kraftwerk was started by two friends, Ralf Hütter and Florian Schneider, both born in the late 1940s, who met at the Düsseldorf Conservatory. In addition to the Western classical music they studied at the Conservatory, Hütter and Schneider were also very interested in Schaeffer and Henry's tape music as well as Stockhausen's experimental electronic music. However, in a departure from the classical and experimental music styles they studied, Kraftwerk was conceived as popular music.

Kraftwerk's machine music features a metronomic groove and self-effacing stage performance style. Repetitive, diatonic melodies instil a floating sense of time outside of tonal cadential formulas. Simple rock and disco rhythmic patterns are played with little variation on electronic drum kits. These elements of style are prescient of the

machine groove present in techno. The first album, the self-titled *Kraftwerk*, was released in 1970. Within Kraftwerk's lengthy discography, *Autobahn* (1974), *Trans Europe Express* (1977) and *Computer World* (1981) are clear sources of the band's influence on techno. Kraftwerk are still active in 2012.

Techno

The history of techno has already been treated extensively elsewhere. Sicko's *Techno Rebels* (1999), for example, constitutes an exhaustive study of the inception of Techno in Detroit. May (2007) summarises the history of Detroit techno in her article in *African American Music*. Halstead (2010) provides a similar summary in his PhD thesis, tracing the evolution of techno as it leads up to Intelligent Dance Music (IDM). However, in spite of the growing body of literature on EDM, Garcia (2010, p. 6) correctly points out "there has been very little work on the 'minimal' spectrum of styles (minimal house, minimal techno, dub house, glitch, microhouse, etc.) that sprang up in the late 1990s."

The transition from techno to minimal techno in early 1990s Detroit takes off from the work of Kevin Saunderson, Derrick May and Juan Atkins in the 1980s. Sicko (1999) identifies the earliest inception of techno in the Detroit High School party scene of the late 1970s and early 1980s. The track 'Sharevari' (1981) incorporates a unison canon in its composition that is reminiscent of the DJ technique used to extend a track by mixing between two identical copies of the same vinyl. This single track underlines the "connection between Italo-disco, techno and Detroit's high school sophisticates" (Sicko 2010, p. 29). It is within this party scene that Atkins and May first

gained experience as DJs. One of the first explicit forays into techno is Atkins' project Cybotron, which was modelled directly on Kraftwerk (*Ibid*, p. 44). The musical structures of Cybotron tracks were not defined in terms of open-ended repetitive processes. Rather, these tracks resemble song forms, complete with vocals organised in verses.

As Detroit Techno departed from song forms, it quickly distinguished itself from electro when it evolved into loop-based structures. For example, 'Nude Photo' (1987), produced by May under the name "Rhythim is Rhythim" is composed of interlocking synth melodies that are very similar to Steve Reich pieces such as 'Vermont Counterpoint'. May's track 'Kaos' (1988) is composed of repetitive drum machine patterns. Development is centred on transformations of the drum machine sounds. The timbres are transformed by modulating the synthesis parameters of the drum machine, as well by modulating the effects with which the drum sounds are processed. The track stops abruptly, a style of arrangement both typical of techno and reminiscent of the early experimental works of Glass, such as *Strung Out* (1967). This abruptness points to an open-ended sense of time, as well as to the fact that these records are intended to be mixed in a continuous long form by DJs. The compilation album *Techno! The New Dance Sound of Detroit* (1988) marks a point where the style crystallised, formally gained its name and acquired a clear distinction from Chicago house.

Minimal Techno

Minimal techno first emerged in the early 1990s and the style is associated with a second generation of Detroit artists. "While the first-wave artists were enjoying their early global success, techno also inspired many up-and-coming DJs and bedroom producers in Detroit" (May 2006, p. 340). This younger generation includes Richie Hawtin, Daniel Bell, Robert Hood, Jeff Mills, Carl Craig, Kenny Larkin, Mike Banks and Alan Oldham. The work of several of these artists evolved to become focused on minimalism. While many projects in other locations, such as Regis in the UK, Basic Channel in Berlin or Mike Vainio in Finland, made significant contributions to minimal techno, this chapter is concerned with tracing those techniques of minimalism that lead to the development of Plastikman in Windsor, across the river from Detroit.

It is important to understand the distinction between minimal techno in the 1990s, and what became known simply as 'minimal' or 'Berlin minimal' in the 2000s. Mike Huckaby explains the difference accurately. "The original sound of minimal techno was made by artists like Rob Hood from Detroit, and Basic Channel from Berlin. The minimal sound of today has blended fashion, drugs, and sex into the definition" (Wasacz 2010). The early sound of minimal techno was focused on a sparseness of material and formal structures that were often borrowed, perhaps unwittingly, from classical minimalism. The difference between minimal techno and minimal, besides the cultural aspects noted by Huckaby lies in the musical parameters on which production is focused. Minimal in the early 21st century can be defined by its focus on timbre. Tracks such as Marc Houle's 'Techno Vocals' and Ambivalent's 'R U

OK?’ are recognisable by their use of down-pitched vocals. Troy Pierce’s ‘Horse Nation’, with its dark sounds and muted sub bass line, is an example of popular minimal sounds. Sherburne’s description of this new approach to minimalism implies a focus on timbre, “massification [...] the strain of EDM that attempts to create extreme densities with a relative paucity of sonic elements” (2004, p. 325). Ricardo Villalobos, an exponent of minimal, is known for his very dense and organic productions such as his album *Alcahofa* (2003). Although Villalobos’ sound is very different from Houle or Pierce, the common link is a focus on timbre rather than process. The popularity of minimal hit its peak in the first decade of the 21st century. Today, the term minimal is often used as an umbrella term to describe minimalism in EDM. This research project is focused on minimal techno from the early 1990s and does not cover minimal in the early 2000s. Three tracks in particular illustrate some of the musical approaches taken in minimal techno.

First, Robert Hood’s track ‘Minus’ is an archetype of minimal techno. The track is featured twice on the 2009 compilation *The Grandfather Paradox* by Henrik Schwarz, Ame and Dixon. It is an extremely sparse production. There are only two instruments, a bass drum and a monophonic synthesiser. The synth plays a polyphonic melody, as in Bach’s Chaconne where a single line is arpeggiated within melody and bass notes. The minor mode melody in ‘Minus’ is reminiscent of Reich’s *Piano Phase*. After a thorough exposition of the theme, and nearly two minutes of repetition, a new tone, the major third, is slowly faded in. Recalling Reich’s technique, this is a process of replacing a rest for a beat. The major third scale degree is in the same register as the minor third

scale degree, thus creating a half-step friction. Once introduced in the pattern, the new, single tone is displaced by a 16th note every eight bars or so. The rhythmic groove of the melodic friction is shifted at each displacement. This is undeniably a phasing pattern, just as in Reich's *Clapping Music*. In regards to the possibility that Hawtin's label was named after Hood's track, Hawtin set the record straight. "Although MINUS is one of my favourite tracks from Robert, it was just a happy accident with the name" (Hawtin 2013, pers. comm., 22 January).

Daniel Bell's DBX track 'Losing Control' was released in 1994. The track is, like 'Minus', extremely sparse. Most of the percussive track is limited to a bass drum on every beat and a hihat on every upbeat. A syncopated snare briefly appears during the track's midpoint. An atmospheric synthesiser is sometimes faded in. The central element is a short vocal loop of a man stating "I'm losing control". Over the track's seven minutes, the voice is filtered and transformed with different effects. Timbre modulation is thus the central mechanism for development. The effect is somewhat reminiscent of Alvin Lucier's *I'm Sitting In A Room* (1969), where a voice is progressively transformed through the resonant frequencies of the titular room. A connection can also be made to Reich's *It's Gonna Rain*. In all cases, a single vocal loop, along with its transformations, becomes the central focus of the music.

Lastly, Hawtin's 'Spastik', another landmark minimal techno track, was released under the Plastikman name in 1993. It is purely a rhythmical track and thus can be mixed with any other track without clashing harmonically. The track is built around a two beat

TR-808 snare pattern consisting of a mix of 16th and 32nd notes. Over the course of nearly 10 minutes, the audio effects and synthesis parameters of the snare are tweaked in all possible directions. Once again, traditional musical parameters of melody and rhythm are virtually static and development is centred on timbral modulation. At various points, subtle elements are brought in to accentuate the track's intensity. Claps, rides and bass drums are introduced and removed. The connecting thread, however, always remains the looping two beat pattern.

There are a common group of composition techniques used in several recent stages of Western music, from Satie to 'Spastik', in which Non-Western musics have played an important role. While minimalism has become unfashionable with contemporary classical composers, as new forms have developed, within EDM it has developed and thrived. Minimalism in EDM is known today under the umbrella term minimal, a designation that should not be confused with minimal techno.

Minimal techno, a sub-genre of EDM that first gained popularity in the early 1990s, is related to preceding minimalist musics through a variety of techniques such as repetition, phasing, indeterminacy and replacement. Minimal techno is often purely electronic, composed of stark sounds and imbued with a mechanical groove. We now turn to the question of how minimal techno is performed, and the relationship between minimal techno and technical innovation.

1. Case Study

1.1 Liine

This chapter discusses the role of custom software development in the performance setup of Plastikman Live. The following questions will be addressed. How is minimal techno performed? What is the relationship between minimal techno and technology?

1.1.1 Background

The instrumentation of house and techno music in the early and mid 1980s consists mainly of old analogue equipment that had suddenly become affordable because of the market's focus on new digital synthesizers such as the Yamaha DX7 (Gilbert & Pearson 1999). Certain machines, such as the Roland TR-909, TR-808 and TB-303, played key roles in this shift (Brewster & Broughton 2006). These machines are discussed in detail by Zeiner-Henriksen (2010) or Kempster (1996).

Hawtin developed a unique approach to exploiting this standard techno instrumentation in Plastikman, as Sherburne explains in an interview with Hawtin:

“Hawtin’s gear was pretty standard for the time: in addition to the 303, there were the usual drum machines (Roland’s TR-606, 808, and 909), an Akai S950 sampler, and Roland and Sequential Circuits synthesizers. But the rubbery, otherworldly sound of Plastikman had as much to do with the ways that Hawtin patched his machines together, routing audio signals through a convoluted chain of effects. (Sherburne 2011)

The Plastikman albums were created through a process of long improvised recordings that were later edited to trim them down to digestible song lengths. This improvisation-based production method was adapted for stage performance in the early 1990s Plastikman shows.

We were using pre-programmed loops and sequences. The 909 was filled with every bank so that was sixteen times four, sixty-four different drum banks, patterns. There was no song structure so I would just go between those. [...] It would just be a combination of, you know, certain patterns went together for certain songs. Certain patterns you could use to kind of bridge songs. I always kind of had an order but you would start somewhere and end somewhere. (Hawtin 2012)

This chapter explains the role and the nature of software created by Liine for Plastikman Live in 2010. The essential difference between the 2010-2011 performances and the early 1990s performances is that by 2010 digital technology had evolved to a point where most of the show could run on software. A software-based setup removes many of the logistical, technical and financial problems associated with hardware studios and performance setups.

1.1.2 Systems

Ableton Live, MaxMSP, Max for Live and LiveAPI

At the heart of the Plastikman Live performance is a computer program called simply *Live* and a crucial extension called *Max for Live*. It is the result of confluence between two companies with very different visions: Cycling 74 and Ableton.

Ableton is a Berlin based company founded in 1999 by Gerhard Behles and Bernd Roggendorf. Behles was one half of techno act Monolake with Robert Henke. Behles is no longer active as a musician, instead dedicating himself entirely to Ableton. Henke, however, chose to stay focused on artistic creation. He is still very active as Monolake as well as in many other projects. See Rapp (2010, pp. 232-245) for a more in-depth history of Ableton, its founders and Henke's work.

Ableton's flagship product is music software called Live. Its purpose, as its name suggests, is to enable music technology based live performance. Ableton has released eight major versions of Live between 2001 and 2012. The software's depth and breadth of features has continually increased to match functionality such as the horizontal audio and MIDI scoring and editing found in traditional DAWs such as Logic or Cubase. It was however the Session View, around which the first version was entirely focused, a non-linear approach that makes Ableton Live a useful tool for live electronic music performance. The Session View allows the artist to arrange audio in a two dimensional grid. Columns (called tracks) represent audio channels in which rows (called scenes)

contain an audio or MIDI clip. Audio/MIDI clips are synchronised in realtime, in fact everything in Live can be done in realtime without interrupting the audio output. Ableton Live allows you to take an arbitrary number of audio sources, each with different lengths and tempos, and perform them live in time with each other. Other DAWs allow you to do this, but it is an offline process. Ableton Live is thus structured to afford live performance, and it is particularly well suited for pulse-based music.



Fig. 1 — Ableton Live

Cycling 74 is an American company founded in 1997 by David Zicarelli. Its mission is to create 'software for the specialised needs of artists, educators, and researchers working with audio, visual media, and physical computing' (Cycling 74 2011). The roots of Cycling 74's flagship product MaxMSP (called simply Max as of 2010) go back to the very beginning of computer music, starting with MUSIC created by Max Matthews

in 1957 at Bell Labs. The first version of Max was created by Miller Puckette at IRCAM in the late 1980s and was soon followed by Max/FTS, the first version supporting digital signal processing (Cycling 74 2011). In short, Max is a product of the academic music community. Much of the music made with Max is pulseless and focused on timbre.

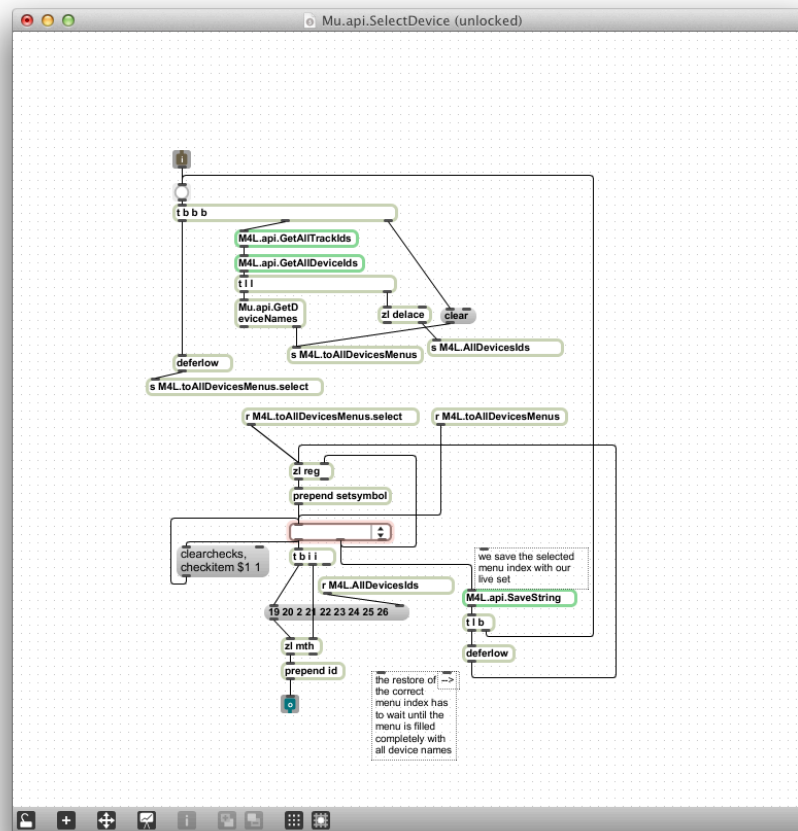


Fig. 2 — Max5

In 2009, the two companies announced news of their collaboration and released Max for Live soon thereafter. Max for Live allows the user to run Max patches from within Live, combining the incredible depth of customisation afforded by the former with the sequencing and pulse-based abilities of the latter. The significance of the collision of

these two musical worlds will be analysed further on. One particular aspect of Max for Live is especially crucial to Plastikman Live. This aspect does not involve any kind of MIDI or audio processing. What it does involve is gaining access to the inner workings of the Live program itself through a bridge called Max for Live API (Application Programming Interface). The amount of information that the Live API can provide the user about the Live set in use is extensive, such as the name, number and colour of tracks, scenes and clips, the global tempo, playback position, the state of effects and return busses.

Mu

An interesting trend in music technology began in 2006 when Brian Crabtree released a simple controller called monomer 40h. It is “a reconfigurable grid of sixty-four backlit buttons” (monome.org website 2011). The particularity of the 40h (and all subsequent monome controllers) is that there is no predefined function. It is entirely up to the user to decide if the buttons and LEDs will act as switches, radio buttons, sample triggers, effect controls or something else entirely. This style of controller, a blank slate of reconfigurable buttons, was adopted by the Arduino open source project, Yamaha (Tenori-On), Akai and Ableton (APC40, Launchpad) and Livid Instruments (Ohm64, Block, Code).

I was very interested in this type of haptic device, but for various reasons never found myself in possession of one. Instead, I acquired in mid-2006 a JazzMutant Lemur with its non-haptic multi-touch screen interface. The Lemur was originally a hardware

device created by French company JazzMutant and released in 2005, a full five years before the iPad. The Lemur was quickly adopted by a slew of world-class electronic music artists, among them Kraftwerk, Einstürzende Neubauten musician Alex Hacke, Nine Inch Nails, Björk, Daft Punk, Richie Hawtin and Justice. It is also worth noting that the Lemur was at times available through Cycling 74 as a non-exclusive distributor in the United States. Lemur can be seen as the multi-touch equivalent of MaxMSP, it lets you build any controller the way MaxMSP lets you build any MIDI or audio process. The Lemur was an incredibly powerful controller but it was also very expensive because it was a boutique item that did not benefit from mass production. It carried a price tag of 2000€. The Lemur hardware was discontinued in late 2010.



Fig. 3 — JazzMutant Lemur

In spite of being committed to working with multi-touch screens rather than haptic interfaces, I nevertheless kept a close eye on the monome community and discussion forums. In 2007 posts started appearing about a topic that captivated me. Artists and hackers were busy reverse engineering the Live API in order to allow them to create tightly integrated custom controllers. Over the next two years this project changed hands many times, eventually culminating with a very useful library called LiveOSC maintained by Stuart Fisher. I used LiveOSC for my own experiments on building a controller for Ableton Live driven by the Lemur. The APC40, based on Henke's Monodeck (Vdovin 2009), integrates exceedingly well with Live, after all, the APC40 was built by Ableton and Akai themselves. The controller, however, does lack a crucial capacity of the Lemur, dynamic high-resolution display.

I set out to build a controller modelled on the APC40 that would display the full range of data in the Live set. The experiment was successful and I showed my work to people at JazzMutant. They hired me to become part of the team that would build Mu, which I saw as the multi-touch answer to the APC40. Mu was to be a piece of software on the Max for Live platform that would allow one to control Ableton Live by touching the JazzMutant Lemur screen. Mu achieved the following goals: displaying the names and colours of tracks, clips and scenes; providing a custom layout of multi-touch objects for each Ableton Device (Audio or MIDI effects); full control of the mixer and a globally reconfigurable layout of these interface elements. Mu was released in March 2010. The release video received nearly 90,000 views on YouTube.

First encounter with Plastikman Live

My first encounter with the Plastikman Live show took place at a general meeting of the entire team involved in creating the show, at Hawtin's Berlin flat in early February 2010. Hawtin had shown interest in Mu for his live performances. A large diagram of the stage was displayed on a flat screen TV, depicting the laptop running Ableton Live, the outboard audio gear (a very large Midas desk, RME audio interfaces, a Serge modular, a Maschine, and more), network connections to the computers running the video synthesis programs, connections to the servers linking the stage computer to hundreds of iPhones in the audience, connections to the stage lighting and various minor systems. The team had already been working together for nearly 6 months. I asked many questions about how the whole system worked, and especially about how performance gestures from Hawtin were expected to control audio, video and lights.

A few days later, on February 15, 2010, I met with Hawtin at his Berlin studio to discuss specifics of the music performance system. I learned how every song planned for the show had been recreated (by ear, trial and error) from the original recordings by Minus artist Jeremy Jacobs, aka JPLS, using software recreations of analogue synthesisers, virtual drum synthesizers and samplers. Samplers were used only in the case of incidental sounds, such as vocals, concrete sounds and digital drum machine sounds that were originally sampled based, such as the Roland TR-707 and the Casio RZ1. Hawtin also showed me how every sound from every drum machine was routed to its own audio channel and how busses were created to mix similar sounds in stems, for

example, a snare bus and a kick bus. Furthermore, the Plastikman Live set uses 12 return tracks in which every single send knob is enabled. This results in a 12x12 modulation matrix used as an expressive dub-style feedback instrument, which is explained in the Plastikman Live chapter. The overall structure of this Live set allows a great deal of control but creates an unavoidable level of complexity due to its sheer size, spanning on average over 150 tracks and 300 scenes, depending on the version of the ALS file. It seemed obvious that using Mu, with its clear display of clip names and colours, could be the basis of an audio performance system for the show.

Hawtin has a history of developing custom hardware and software for his performances either with his father's help, a robotics engineer, or through collaborations with other companies such as Ableton or Allen & Heath. Hawtin was also instrumental in developing and popularising Final Scratch, one of the first digital vinyl system. This time, Hawtin wanted Gareth Williams, who was soon to become my business partner at Liine, and me to create software that would help make possible the level of interaction he envisioned for Plastikman Live.

The first thing I did was to remove all the components of Mu that were not going to be useful in Plastikman Live, which amounted to essentially everything except the clip launcher. Optimising the performance system is a constant concern in Plastikman Live, both to make the human-machine interface as intuitive as possible and also to keep the computers from crashing.

The first problem we tackled was how to navigate through the colossal array of clips. Fortunately, not all 150+ tracks in Hawtin's Live set necessarily need to be displayed. The vast majority of them, as explained above, are part of a routing and bussing system setup to facilitate a good mix and help make the soundman's job easier. Hawtin reorganised the tracks in the Live set so that all those relevant to performance, that is those which contain audio/MIDI clips he might want to trigger, are found in the first 36 tracks. I then modified Mu to display only the first 36 tracks of the set. The navigation controls, conceived initially as scroll bars, were simplified on the horizontal axis as three bank buttons. On the vertical axis the controls were changed to permit moving the view in large blocks of scenes rather than with a continuous scrollbar. In the non-realtime medium of the recording studio, the software required the detail that a scrollbar permitted, but for Hawtin's purposes a more robust and simplified navigation was created as a bespoke solution.

We also devised a system as an extension of the simplified navigation controls to quickly jump to an area containing clips from a specific song. I built a new page in the Plastikman Lemur template that displays all the names of the songs as large buttons. Tapping one of these buttons instantly moves the view to the appropriate track and scene offset. With this system of bookmarks, one on each Lemur, left and right, Hawtin could effectively play the clips of two different songs simultaneously, mixing not two vinyls, but an intricate and improvised arrangement of the different parts of two different songs.

1.1.3 Kapture

Using and modifying Mu solved the problem of how to navigate the landscape of clips. The bookmarks system afforded a quick way to jump to any song. Yet, there was still one big problem to solve. As previously mentioned, bus tracks are extensively used in Plastikman to create dub style chains of delay feeding back onto themselves. Drum machines are carefully split up into their individual sounds, and each one of these is treated and mixed separately. However, each song demands a very different configuration of the mixing desk and very numerous effect plug-in settings.

Hawtin already had a clear vision of what needed to be accomplished. We discussed the problem and decided to use a snapshot feature. A snapshot would remember the exact position of every single volume knob, send knob, effect parameters, and various minor mixer settings. It should be possible to load a snapshot and expect the settings to be applied to the Live set. Needless to say, the process should be seamless, without interrupting the audio stream. I created the first version of Kapture to achieve this functionality.

It was not entirely clear to me how this would be accomplished, from a technical point of view. I intended to use a programming language called JavaScript, a language at which I was a complete novice. JavaScript is a simple language initially created in the late 1990s for little widgets on the web. Cycling 74 implemented a version of JavaScript inside Max, and inside this they created an object called LiveAPI. This object, as described previously, interfaces with the inner workings of Ableton Live.

Mannheim Premiere

The premiere performance of Plastikman Live was scheduled for March 27, 2010 at the Time Warp party in Mannheim. Time Warp is a long-running festival, held yearly since 1994, usually in Mannheim. Rehearsals were scheduled over two days and nights, March 1 and 2, at the same venue where the event was to be hosted. The whole team, comprising nearly 20 people, whose individual specialties covered the wide range of the show's requirements, took the train together from Berlin to Mannheim. For many of us, myself included, it was the first time we had met. We travelled in a first class carriage reserved for ourselves with ample space to work on our laptops. The next two days would prove to be exhilarating and challenging. The deadline for getting the show ready to be presented in public was very short.

I had already completed the Mu modifications. My next task was to create Kapture and get it working. From what I had read, I knew the LiveAPI object could do the job, but the task stretched my abilities, as programming had always been a hobby for me, my formal studies were in music. Making smooth transitions between songs possible was extremely motivating.

Hawtin's equipment is surrounded by a semi-transparent half-cylinder of high resolution LEDs, affectionately called "the cage". The visuals team was busy testing it with stroboscopic animations of the Plastikman logo while the sound engineer was working with Hawtin on tweaking the mix. The resulting environment, although in some

ways enjoyable, was a constant barrage of very loud TB-303 and drum machine sounds that were accompanied by an onslaught of fast-moving psychedelic visuals. The whole team was working on tables set up approximately 50 feet from the stage and speakers.



Fig. 4 — Plastikman Live, inside the cage

I developed Kapture while working at this table in Mannheim, with help from Williams who meticulously tested a new version every half-hour. I would periodically copy the latest version and test it on Hawtin's laptop. Incorporating Kapture into Plastikman Live was a process of trial and error, improvisation and experimentation, with the stage as our collective laboratory. Hawtin's performances were the ultimate testing ground for Kapture and, a few months later, Griid and Kapture Pad.

Kapture is an example of repurposing technology. Much in the same way that the TB-303 was “originally marketed as a bassline generator to accompany solo musicians” (Sicko 1999, p. 72), but was appropriated by techno artists for an entirely different purpose, that of a characteristic solo instrument in acid techno, Kapture uses Max for Live in a way which is wholly unintended by its creators Ableton and Cycling 74.

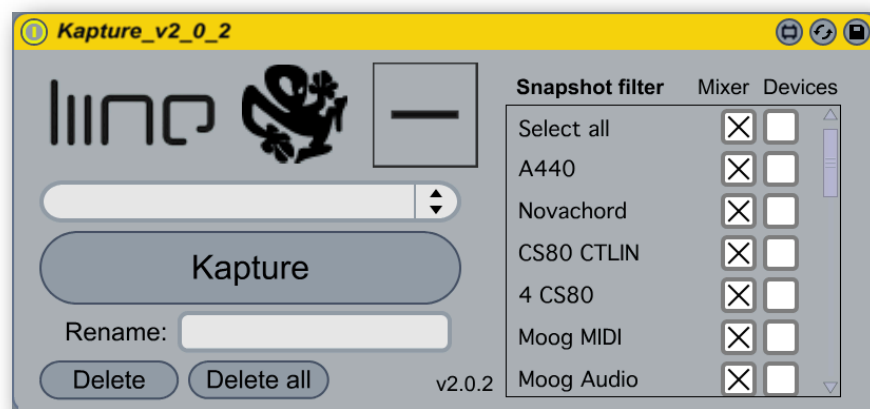


Fig. 5 — Kapture

I realised to just what extent we had pushed technology during a conversation with Stefan Brunner, product manager of Max for Live, over a year later. At the Berlin Music Hack Day event in May 2011, Brunner complimented Liine on Kapture and related how surprised he was that Kapture actually worked. He confided that he would have assumed such a thing was impossible and that he would not have attempted to do it. It is interesting to note that although Max is used by contemporary classical musicians for live performance, patches are often notoriously unstable, and liable to crash mid-performance. With stadium audiences in the tens of thousands, the solution for Hawtin

had to be far more stable. Brunner jokingly asked one of my partners and me if we were looking for jobs. Our response was to ask him the same thing.

After a few more days of work and testing in Berlin, Kapture seemed to be robust. The whole Plastikman Live team went back to Mannheim a few weeks later for the premiere performance. I was on edge for the entire show, hoping that Kapture, Mu and the various other Lemur and Max for Live patches would not cause Ableton Live to crash. They did not and the performance was a total success. Kapture 1.0 was released to the public later that year in October 2010. The custom version of Mu was never released to the public, and remained a boutique solution to Hawtin's needs.

Liine's inception

Liine was founded in April 2010 by myself, Richie Hawtin, John Acquaviva, Etienne Noreau-Hébert, Mark Quail and Gareth Williams. We created Liine to set up the infrastructure necessary to commercialise our work. A business opportunity to create multi-touch controller software presented itself when Apple announced the iPad, which was released on April 3, 2010. The Lemur was at a severe disadvantage when compared to the iPad's similar functionality, higher resolution, higher frame rate, more powerful CPU, smaller form factor and substantially lower cost. For these reasons, my colleagues and I saw that the iPad would allow us not only to build a better human-machine software interface, but also to disseminate our work to a large public at an affordable price. Our motivations until then had been artistic and technological. Acting through Liine, our interests were from then on threefold, artistic, technological and

commercial. In addition to releasing Griid and Kapture, both described below, Liine acquired the rights to and released Lemur as an iPhone / iPad app in 2012.

The core team, directly responsible for creating and marketing products, is composed of Noreau-Hébert, Chief Technical Officer; Williams, Managing Director; and me, as Creative Director. Designing products is part of my official responsibilities. In reality, especially in the very early days of Liine, there is a large degree of overlap in our day-to-day tasks. Griid and Kapture Pad, Kapture's successor on iPhone and iPad, were very much the result of team efforts involving not only the core founders but also external collaborators such as Stuart Fisher.

1.1.4 Griid

Griid is an iOS controller app entirely dedicated to controlling Ableton Live's Session View. The app was premiered during Plastikman Live during the Detroit Movement Festival in May 2010. The exact venue was Hart Plaza, a fitting place for Hawtin to perform given its significance in techno music history (Sicko 2010, p. 2). Griid's development was driven by a purist approach focused on providing the live musician with the best possible clip launcher. Hawtin's Live set, with its massive clip grid, challenged us to find the most efficient navigation controls, those which would hopefully remove layers of abstraction and minimise the perceived distance between the body and the machine. We wanted to create an interface that felt natural and immediate, which would feel as obvious as opening a book or plucking a string.

Functionality in the initial version was strictly limited to the Session View's clip grid and did not offer any options to control other parts of Live such as the mixer or effects. I spent many days debating micro-details of Grid's appearance and gestures with Williams and Noreau-Hébert, for example the exact aspect ratio of a clip, whether scrolling should be allowed everywhere in the clip grid, or if it should be restricted to a column on the side otherwise used for launching scenes.



Fig. 6 — Grid

Through trial and error, feedback from Hawtin, and later from other artists to whom we demonstrated prototypes, we learned how to make Grid as smooth, intuitive and responsive as possible. Grid was released to the public on the iTunes App Store in August 2010.

The details of this work on Griid's design, specifically on its appearance, navigation and gestures, is summarised below.

Appearance

We strove to make Griid's appearance as simple as possible. The information needed by the performer is clearly presented and any extraneous information, that which is not required in performance, is simply not displayed.

For example, the crucial information about the Session View needed by the performer is the full name and colour of clips, tracks and scenes, as well as the playback information, about which clip is playing on which track and the progress of the playback head. Our team long debated exactly how clips should be represented in Griid. A solid coloured rectangle, as it was in the Detroit version allows readable text for many colours but it is problematic in certain cases. If the text is white, then the clip name is illegible against the background of any pale clip. Conversely, if the text is black, then the clip name is illegible in the case of any dark coloured clip. This issue is not addressed in Ableton Live itself. The program permits illegible combinations of text and clip colours. Our solution was to display the colour in a solid band at the bottom of the clip. This portion of the clip never changes. The top portion decreases the brightness of the colour. The text, white when the clip is not playing, is always legible against the faded colour. When the clip is playing, the top portion turns solid white and the text turns black. This scheme ensures that at any time, the performer may instantly

gather the three crucial pieces of information, in one single place, about the clip, its name, colour and playing status.

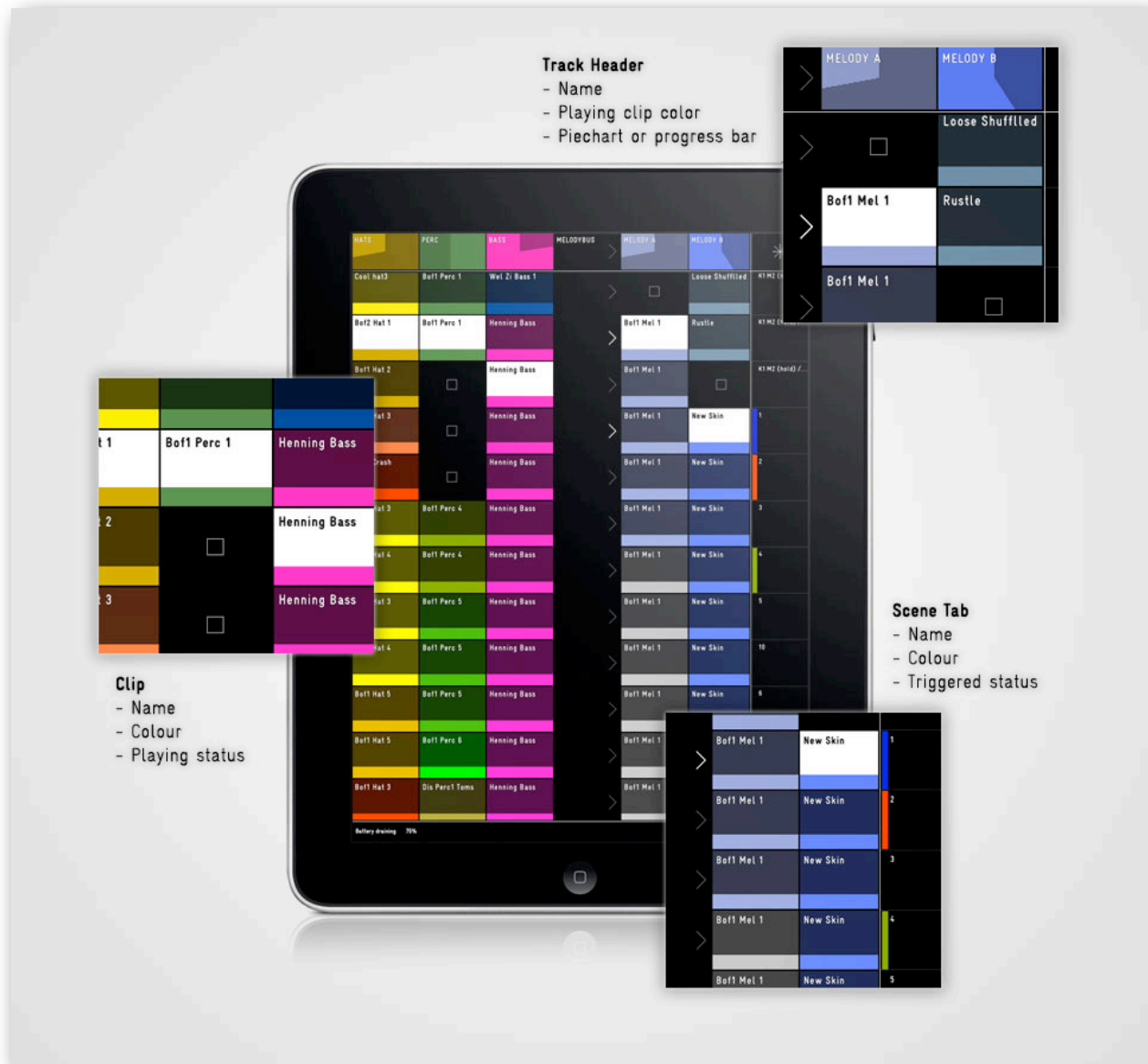


Fig. 7 — Grid, clip detail

Another example of how we streamlined Grid's appearance is the way different parts of the user interface are spaced and differentiated. The most simple of dividers, a line one pixel wide, delineates the clip grid, the tracks headers at the top, the scenes on

the right-hand side and the information area at the bottom. The background is completely bare, pure black and devoid of any decoration. Functions are represented by symbols, such as the shift button in the upper right-hand corner or the overview button in the lower right-hand corner for example.

The last significant detail of Grid's appearance is the way we animated the progress of a clip's playback. The playback of looping clips is represented by a circular clock while that of a one-shot clip by a rectangle being filled from left to right. Getting the playback animations perfectly smooth and in sync with the actual audio in Ableton Live was a substantial challenge. Noreau-Hébert, whose computer science background includes working on data compression for cell phone communication, devised an algorithm that estimates when the next packet will arrive based on the current tempo and length of the clip. In short, his code smoothed out latency and jitter caused by the wireless network in order to provide a clear visual reference for the performer's benefit.

Navigation

As Grid was first developed specifically to perform Plastikman Live, the question of how to effectively navigate the colossal clip grid was of chief importance. The solutions to this problem of musical performance are threefold: inertia scrolling, overview and jumping.

Whereas Mu merely allowed the user to scroll through scenes and tracks by repeatedly tapping buttons, either to move the view one unit or a multiple of units corresponding

to the current size of the view, Griid allows the user to smoothly scroll the view by dragging a finger in the desired direction. The feeling is intuitive, as easy to understand as moving a piece of paper across a table surface. By quickly swiping his finger and then releasing the point of contact, the user causes the view to continue moving at a speed relative to that of the swipe gesture. The movement has inertia and continues until friction slows it down and finally stops it. This style of gesture was certainly possible on the Lemur, but not in the case of a large grid of data. The movement is familiar and feels natural to any iPhone or iPad user, as it is pervasive across the iOS platform. Smooth scrolling with a finger swipe permits quick navigation in a small area, such as a song that spans 30 scenes. Inertia scrolling by releasing a quick finger swipe permits fast navigation across larger areas, for example if the performer wants to explore the next few songs and visually scan the clips to find the desired part.

For the cases where the distance to travel is greater than that afforded by even a very quick inertia scroll gesture, we created a visual device called the overview. Accessed by tapping a button in the lower-right right-hand corner of Griid's interface, the overview shrinks the entire Session View so that it completely fits in the iPad's screen. Each clip is reduced to a tiny coloured rectangle. The overall effect is that of a map. A brightly lit rectangle indicates where the normal view is located, and it can be dragged or instantly moved by tapping or dragging it. Playing clips can be easily identified by their pure white colour and their slightly bigger size. We made them one pixel bigger, so the eye is immediately able to pick out the playing clips from the map.

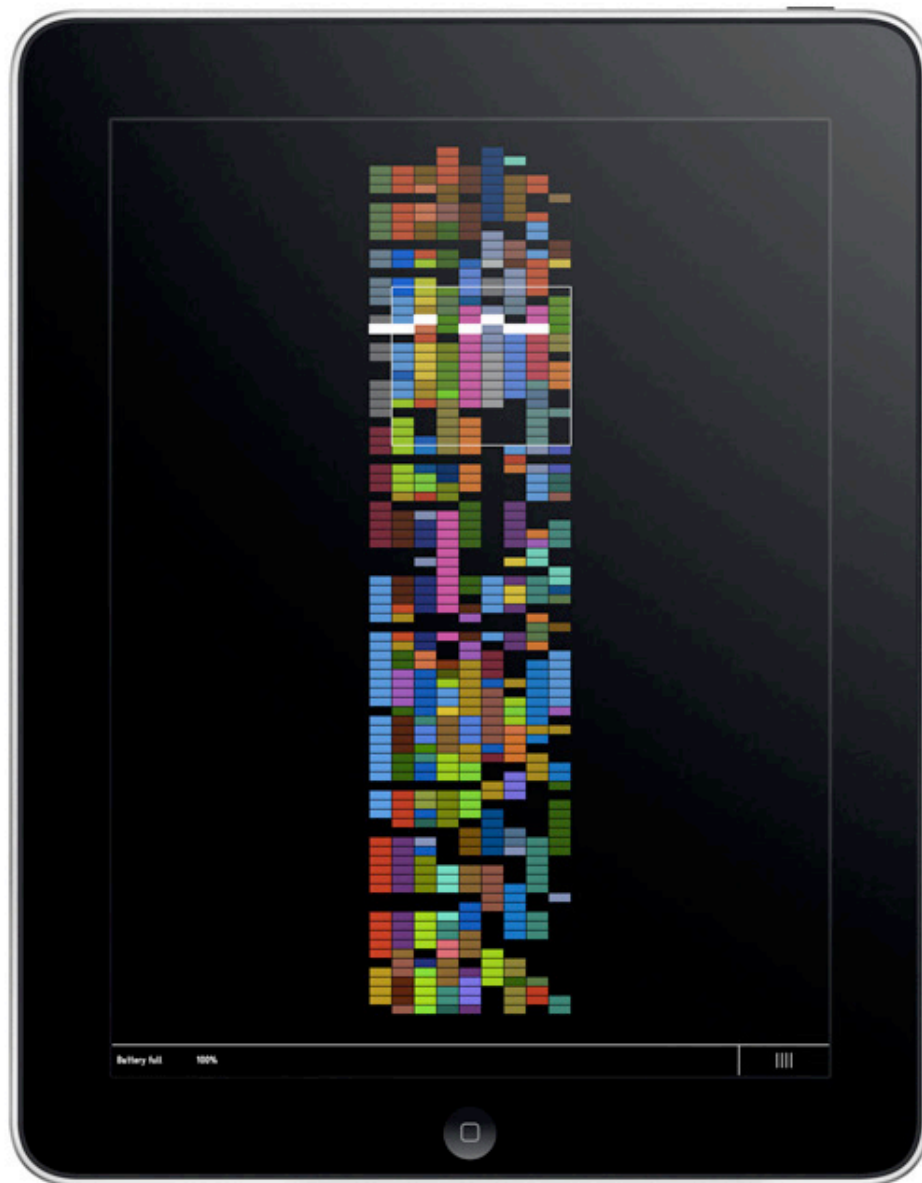


Fig. 8 — Grid Overview

Both these solutions, smooth inertia-enabled scrolling and the overview, allow Hawtin to mix any clips from any songs with each other. This creates a situation where at any given time the playing clips can easily be very far from each other. We needed to find a way to quickly move the view to the playing clip on any track. With the playback

animations it is easy to see whether a given track has a clip playing or not. By tapping the playback animation, the view instantly jumps to show the area of the grid containing that clip. This shortcut, in combination with the two aforementioned navigation functions, creates an all-encompassing solution for navigating the Plastikman Live clip grid.

Gestures

Some interactions in Griid were intentionally based on familiar gestures, for example the previously described inertia scrolling. The iPhone had already been out for a few years and people had come to expect certain gestures to do certain things. Gestures such as a two-finger pinch had become ubiquitous in general use. We discovered, however, that in the case of a musical controller, the standard set of gestures could not always be used without hindering the performance experience.

The first working version of Griid, used by Hawtin at the Mannheim premiere, afforded no less than three types of gesture in the clip grid. A single tap would launch a clip, a two-finger pinch gesture would zoom the view and a single finger swipe would scroll the view. Although Hawtin got used to this system and used this beta version for many performances, we found that the multiplicity of gestures confused other artists whom we invited to try Griid.

The problem is that to determine a gesture, the software must introduce a short delay to analyse the finger's movements and decide what the user means. The time

necessary to analyse a gesture is directly related to the accuracy of the analysis. Latency is the bane of electronic music systems. Just as a piano sounds immediately when a key is pressed, or a guitar string sounds when it is plucked, so should Live respond just as quickly when the user touches the controller. Furthermore, the gesture detection can sometimes be wrong. While that is not a problem for a casual multi-touch app such as a game or an address book, it can be disastrous in a musical performance if, for example, instead of scrolling the view the software launches a thundering kick drum clip.

For these reasons, both speed and accuracy, we learned that a multi-touch music controller should allow only one type of gesture per area. Consequently, the only gesture available in the clip grid is a tap to trigger a clip or a stop button. Multiple touches are interpreted as multiple taps, and thus any combination of clips simultaneously. Since the gesture does not need to be analysed, it feels as if the response is immediate when the clip is triggered. Swipe and pinch gestures for zooming or scrolling are restricted to the track row and scene column. Even in the scene column, where the user can launch scenes in addition to scrolling and zooming, the area for the first and the area for the other two are mutually exclusive. Launching a scene is triggered by tapping the left-hand third of a scene, identified by a thin coloured band. Scrolling and zooming is available in the remaining area of the clip. The software was acting as an interface between man and machine, with our aim being to make this relationship seem as direct and unmediated as possible. We provided a

technical solution to enable a complex mapping between human gesture and machine-generated music.

Man and Machine

Rietveld writes about the relationship between technology and people, both dancers and musicians, in *Sacrificial Cyborg and Communal Soul* (Rietveld 2004). Essential points as they relate to the performance technology in Plastikman Live can be summarised as follows.

Rietveld describes dancing to techno music as an embodied experience that lets people get out of their head. Rietveld uses the notion of a body and spirit duality to support a description of that experience. Any sub-genre of EDM can produce sensory over-stimulation, which in turn can lead to an altered state, whether that of trance, ecstasy or transcendence (Sylvan 2005). Different EDM sub-genres may produce different flavours of imagery and emotion but the result, an alteration of one's relationship with the self, is the same. For example, techno can be understood as "futuristic electronica and industrial nostalgia" (Rietveld 2004, p. 50). House, on the other hand, provides "ritual musical structure to [...] an 'inclusive 'church'" (*ibid*, p. 50). The combination of House and Techno elements can create a "powerful means of confirming a [...] relationship with technology" (*ibid*, p. 50). The DJ plays the role of guide, leading dancers through the peak-experience of this relationship. Griid works to help that relationship by serving as a technological interface between the performer's mind and the dancers' bodies.

Rietveld also discusses the mind-body problem, a central issue to the challenge of designing Griid, an interface whose purpose is to seamlessly bridge the mind and technology via the performer's body. Rietveld's concept of "techno-shamanism" is embodied through Hawtin in the cage. She writes: "Not only do dancers give themselves up to the machine metaphors of the music; there is also a self-absorbed masculine pleasure in taking control over this cyborg relationship, as DJs, producers and programmers" (*Ibid*, p. 56). A relationship exists between people and machines during a techno event and there is a leader who enjoys controlling it. Plastikman Live is an example of the latter. Hawtin is surrounded by an immense array of machines. On stage, he is quite literally inside the machine. The work we did with Lemur, Griid and Kapture served to extend the capabilities of one man and enable him to gain superior control of the machines. The existence of a cyborg relationship could not be more clearly represented. The gestures of his hands are extended into the machines using our software, in an instinctive fashion that enables invisible networks of notes and beats to feel as though they are emerging directly from Hawtin's hands. His abilities as a human being are extended by virtually attaching drum machines and synthesisers to the ends of his arms. I experienced this relationship between man and machine during my own composition work, described in section 2.8.

As a member of the company who created Griid, I was involved in creating software to further this relationship between man and technology. My insider viewpoint allowed me to witness the sheer complexity of the technological systems being developed for such

large scale interactions with stadium sized audiences. These technological developments are usually hidden from the audience in order to make the interface between machine, man and audience seem invisible and effortless. In the next chapter, we will see how this relationship is worked out in a case study of one of the tracks of Plastikman Live.

1.2 Plastikman Live

1.2.1 Introduction

Whereas the previous chapter focused on the interface between the performer and the machine, we now turn to the music itself. This chapter describes and analyses the Plastikman Live set, first at the level of the overall structure followed by a detailed analysis of a single track. This will inform us of how a minimal techno performance can be structured. The analysis will also provide a context from which to draw theoretical links to historical, technological and commercial issues.

Plastikman was originally a studio project created by Hawtin in the early 1990s. Hawtin played 14 live shows under that name during that period. The project was revived once in 2004 for a single live show at Mutek in Montreal. The project was revived again for a live tour in 2010-2011, in large part due to the fact that available software technology had sufficiently evolved. This chapter analyses the live performance methods from the 2010-2011 tour.

By virtue of my professional relationship with Richie Hawtin, I obtained a copy of the entire data folder for the Plastikman Live show as well as multi-track recordings for one of the performances. The data folder contained files such as Ableton Live .ALS sessions, banks of drum sounds and field recordings sampled from the original recordings, Lemur templates and Kapture banks.

Structure of analysis

The analysis of Plastikman Live focuses on the Ableton Live Set from early November 2011, as well as an audio recording of a performance in Madrid on October 29 2011. The earliest sketches of the Live Set had begun in late 2009, and just as the visuals, setlist and overall feel of the show evolved constantly, the Live Set was in constant mutation right up to the very last shows in late 2011.

Plastikman Live can be seen as an open score, akin to Riley's *In C*, but taken to a much higher degree of technological complexity. The Live Set analysed here encompasses a grid of 142 tracks by 315 scenes. The Set enables a large degree of improvisation around small and predetermined musical materials. Consequently, the analysis underscores the possibilities offered by the macro-structure rather than transcribing a recording of an individual show. The musical materials of one composition, however, are transcribed and analysed in order to provide an example of the lowest level of information in the Live set. Original tables and diagrams support pertinent information about the overall structure, including the tracks and drum routing, clips and scenes structure, as well as the return tracks effects matrix.

The analysis is comprised of three sections. The first explains the structure of the tracks and scenes, as well as the instruments and samples used as audio sources. The second focuses on the effects and Kapture Pad. The third analyses one track in particular, 'Plasticine'.

Terminology

Terms used to describe EDM or music technology have a specific meaning when applied to Ableton Live. A list of definitions follows in order to disambiguate the terms.

Arrangement View: One of two modes of organising musical material in Ableton Live, it is a horizontal, left to right graphical arrangement of audio and MIDI clips which resembles a traditional ensemble score by its horizontal superposition of voices. The Arrangement View is not used in Plastikman Live.

Session View: A two-dimensional grid composed of columns, known as “tracks”, and rows, known as “scenes”, whose individual cells known as “clip slots”, may or may not contain a clip. The Session View resembles a spreadsheet where the rows are called scenes and the columns are called tracks. Plastikman Live was created and performed in the Session View.

Track: A single column in the Session View, a track can generate and process either audio or MIDI data. “Track” most often designates a recording in EDM, but designates MIDI and audio channels in Ableton Live.

Return Track: Tracks specifically available for bus effects. Ableton Live allows a maximum of 12 Return Tracks. Normal audio tracks can also be used for bus mixing with clever routing techniques. The exact track configuration and routing structure in Plastikman Live will be extensively covered.

Clip: A clip, which may have any loop length, contains MIDI or audio data. Clips are used extensively in Plastikman Live to carry drum patterns, TB-303 and other synthesiser patterns, as well as various vocal samples and incidental sounds.

Scene: A scene is a row, a horizontal cross-section of all the tracks that is typically used to launch a number of clips on some tracks, and simultaneously trigger stop buttons on other tracks. Each clip slot may or may not contain a clip. If that particular clip slot does not contain a clip, the clip slot may or may not have a stop button.

Song: Song is a term designating a single composition, which, in the context of Plastikman Live, showcasing 14 songs, does not refer to a form of vocal music.

Graphs and diagrams

The Plastikman Live Ableton set is extremely large. Its macro-structure may be more fully grasped with graphs created to better visualise the data. The full list of graphs and diagrams is detailed in appendix II.

1.2.2 Tracks, Scenes, Instruments and Samples

The Live Set contains 142 tracks, the majority of which are used for routing MIDI and audio data. A few more tracks serve to send or receive data to external systems such as crowd iPhones, visual software TouchDesigner or the show's lighting system. Liine

created a special version of Griid which limited Hawtin's access in performance to only the first 36 tracks, the ones that contain performance clips.

The first 12 tracks, named DRMx, where x is the number of the track, are a core component of the performance methods. A single clip on any of these tracks can trigger any drum sound. Every song in Plastikman Live uses a different combination of drum sounds. For example, 'Ask Yourself' (Plastikman 2003) uses the Drumazon kick drum sound and a RZ-1 clap sample, amongst other sounds. Drumazon is a software emulator of the analogue TR-909 drum machine, which operates as a plug-in within Ableton Live. 'Plasticine', on the other hand, uses a TR-808 bass drum sample and the Drumazon clap. However, in both cases notes in clips on the DRMx tracks trigger the sounds. Different MIDI notes trigger different sounds in different drum machine plugins. The TR-909 kick for 'Ask Yourself' is MIDI note F2, whereas the TR-808 kick for 'Plasticine' is E7. The RZ-1 clap for 'Ask Yourself' is A6, whereas the TR-909 clap for 'Plasticine' is B2. All the DRMx MIDI tracks are routed to the MIDImix track, which in turn is routed to all the drum plugins. The Drum Routing diagrams depict the breakdown of all the drum machine plugins, both for the entire Live Set and filtered for each track.

Each scene corresponds to a different section of a song. A section typically lasts 8 or 16 bars, but the choice of when to trigger the next scene is up to Hawtin in performance. Furthermore, Hawtin always had the option to trigger any clip, from any

song, at any moment. Hawtin tended to rely more on the scenes in the earlier shows, and to improvise more as the tour progressed.

A complex routing system involving over a hundred tracks is necessary to enable independent mixer and effect settings for every single drum sound, a crucial component of the Plastikman sound. For example, the D16 Drumazon plugin is loaded on track 56. Drumazon, like the original Roland TR-909 drum machine it emulates, can generate 11 different sounds. The first sound, the kick drum, is output on track 56 where the plugin itself is loaded. The next 10 sounds, however, are each routed to their own audio track (tracks 57 to 66). So, a total of eleven tracks are used for Drumazon, one for each sound. Each track has its own mixer channel strip and can accommodate effect plugins. This structure is repeated for each drum plugin. See tracks 56 to 132 in the table below for a commented list.

Audio tracks used for single drum sounds are not routed directly to hardware outputs. Each audio track is routed to one of 16 virtual 'mixer' tracks. Tracks 40 to 55, identified by name with the 'mix' suffix, are effectively used as audio busses. These 16 tracks each go to their own hardware output, where the signal is then patched to a hardware mixer at the front of house. The only path for audio to exit the Plastikman Live Set is through these mixer tracks. In a similar fashion, all the synthesiser plugins such as the AudioRealism ABL2 TB-303 plugin and Native Instruments Pro-53 are routed to one of the 16 audio bus tracks.

There are several different ways to generate similar drum sounds in the Plastikman Live Set. Not only is the Roland TR-808 emulated twice, first with the D16 Nepheton plugin and then with the AudioRealism ADM plugin, but the Ableton Drum Rack also contains many samples recorded from a hardware unit. Hawtin found that no single plugin could generate an accurate version of all the TR-808 sounds. Depending on the tone control settings of the various sounds, different plugins gave a better result for the settings necessary for different songs. Therefore, a combination of different sources is used to get the best possible combinations. For example, Hawtin tends to use the congas from Nepheton and the toms from ADM. In earlier versions of the show, the kick drum from Drumazon was often used. In later versions of the show, including the one used for this analysis, Hawtin tends to use TR-909 kick drum samples loaded in the Drum Rack. These small differences between different plugin emulations, or between plugin emulations and a sample from the actual hardware, are sometimes minute. Yet, these small differences, in combination with each other contribute to make a significant difference in the overall sound. On the other hand, the difference between sound sources is sometimes striking. At the rehearsals for Time Warp 2010 in Mannheim, the sound of the hardware TR-808 kick playing through the PA was notably different when compared to the same sound coming from Nepheton. A sample of a TR-808 kick drum was often used, therefore, rather than a synthesised version from Nepheton or ADM. A hardware TR-808 was used in the 'Spastik' finale for the first few months of the tour, but was later abandoned in favour of software plugins for technical reasons. The exact combination of drum sounds is depicted for each song in the Drum Routing diagrams.

As Zeiner-Henriksen (2006) has made clear, the difference between a TR-808 and TR-909 bass drum is as important and significant a choice for an EDM artist as perhaps the choice of whether to use a clarinet or oboe for a classical composer. This is clearly illustrated by the lengths that Hawtin was willing to go to in order to get detailed control of the timbre of bass drum parts, while needing the flexibility and control available from computer based methods.

Table of Tracks, Instruments and Samples

#	Name	Description
1-12	DRM1 to DRM12	MIDI clips — drum patterns triggered from Griid
13-14	303B1 and 303B1	AudioRealism ABL2 TB-303 — bass patterns
15	303midi2touch	MIDI from ABL2 to TouchDesigner visuals software
16-17	303M1 and 303M2	AudioRealism ABL2 TB-303 — melody patterns
18	Pro53string	Native Instruments Pro-53 — string sounds
19	SAMBass	Audio clips — bass and vocal samples
20	SAMvox	Audio clips — vocals and aeroplane
21	SAMefx	Audio clips — various punctual synthesiser effects
22	WAVEstation	Korg Wavestation VST — choir sounds
23	FM8low	Native Instruments FM8 — low string sounds
24	FM8high	Native Instruments FM8 — high string sounds
25	SAMstringlo	Audio clips — strings
26	KONTAKTvox	Native Instruments Kontakt — Hawtin vocals
27	DISCvox	Native Instruments Battery — Hawtin vocals
28	OPbass	Ableton Operator — bass sounds
29	M1string	Korg M1 — ambient sounds
30	MidiMix1	MIDI track to bus MIDI data from all DRMx tracks to all drum plugins
31	Kapture Pad	MIDI clips — specially named clips to load Kapture Pad snapshots
32	TOUCHnew	MIDI clips — sending MIDI data to TouchDesigner visuals software

#	Name	Description
33	f130-236	MIDI clips — sending MIDI data to lighting desk via DMXIS plugin
34	f237-289	MIDI clips — sending MIDI data to lighting desk via DMXIS plugin
35	MASC1	Native Instruments Maschine — setup as MIDI controller for drum plugins
36	Maschine10ms	MIDI routing track for Maschine routed to MidiMix1
37	MIDIrecord	MIDI track to record patterns from Maschine
38	iPHONElogikal	Track with Max for Live plugin to receive input from crowd iPhones
39	DMXsynk	Track to interface with lighting systems
40	909kickmix	Audio bus (see Drum Routing diagram) to hardware output 1
41	808kickmix	Audio bus (see Drum Routing diagram) to hardware output 2
42	SNAREmix	Audio bus (see Drum Routing diagram) to hardware output 3
43	CLAPmix	Audio bus (see Drum Routing diagram) to hardware output 4
44	Hihatmix	Audio bus (see Drum Routing diagram) to hardware output 5
45	PERKmix	Audio bus (see Drum Routing diagram) to hardware output 6
46	TOMmix	Audio bus (see Drum Routing diagram) to hardware output 7
47	303bassmix	Audio bus for bass ABL2 TB-303s to hardware output 8
48	303melodymix	Audio bus for melody ABL2 TB-303s to hardware output 9
49	SAMBassmix	Audio bus for samples to hardware output 10
50	SAMefxmix	Audio bus for samples to hardware output 11
51	STRINGlow	Audio bus for strings low to hardware output 12
52	STRINGhigh	Audio bus for strings high to hardware output 13
53	VOXmix	Audio bus for vocals samples to hardware output 14
54	PLUGINmix	Audio bus from Return Tracks to hardware outputs 15/16 (stereo)
55	EFXmix	Audio bus from Return Tracks to hardware outputs 17/18 (stereo)
56-66	<Drumazon tracks>	Drumazon TR-909 plugin and audio routing tracks for each sound
67-78	<Nepheton tracks>	Nepheton TR-808 plugin and audio routing tracks for each sound
79-90	<ADM tracks>	AudioRealism ADM TR-808 plugin and audio routing tracks for each sound
91	707727	Ableton Drum Rack with TR-707, TR-727 and other samples (see below)
92-100	<various>	Audio routing tracks from Drum Rack for various samples

#	Name	Description
101-113	<707 tracks>	Audio routing tracks from Drum Rack for TR-707 samples
114-117	<808 tracks>	Audio routing tracks from Drum Rack for TR-808 samples
118-126	<909 tracks>	Audio routing tracks from Drum Rack for TR-909 samples
127-128	<727 tracks>	Audio routing tracks from Drum Rack for TR-727 samples
129-135	<Nithonat tracks>	Nithonat TR-606 plugin and audio routing tracks for each sound
136-132	<Casio RZ-1 tracks>	Audio routing tracks from Drum Rack for Casio RZ-1 samples

Table 1 — Plastikman Live Ableton Tracks

1.2.3 Effects

Overview

Return Tracks are special tracks used to host effect plugins. Audio signals from any Audio Track in the Live Set can be routed to a Return Track. The signal from a Return Track itself can be routed to any other Return Track, including itself. This creates the potential for audible feedback. There are twelve Return Tracks in the Plastikman Live setup, the maximum number allowed by Ableton Live.

The channel strip on the right highlights the Send knobs that control the amount of signal to send to each Return Track.

The screenshot below (Fig. 10) shows the twelve Return Tracks, each with twelve Sends. The table following (Table 2) lists the effect plugins active on each Return Track.

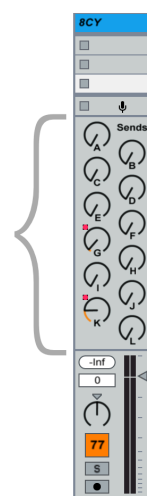


Fig. 9 — Return Track

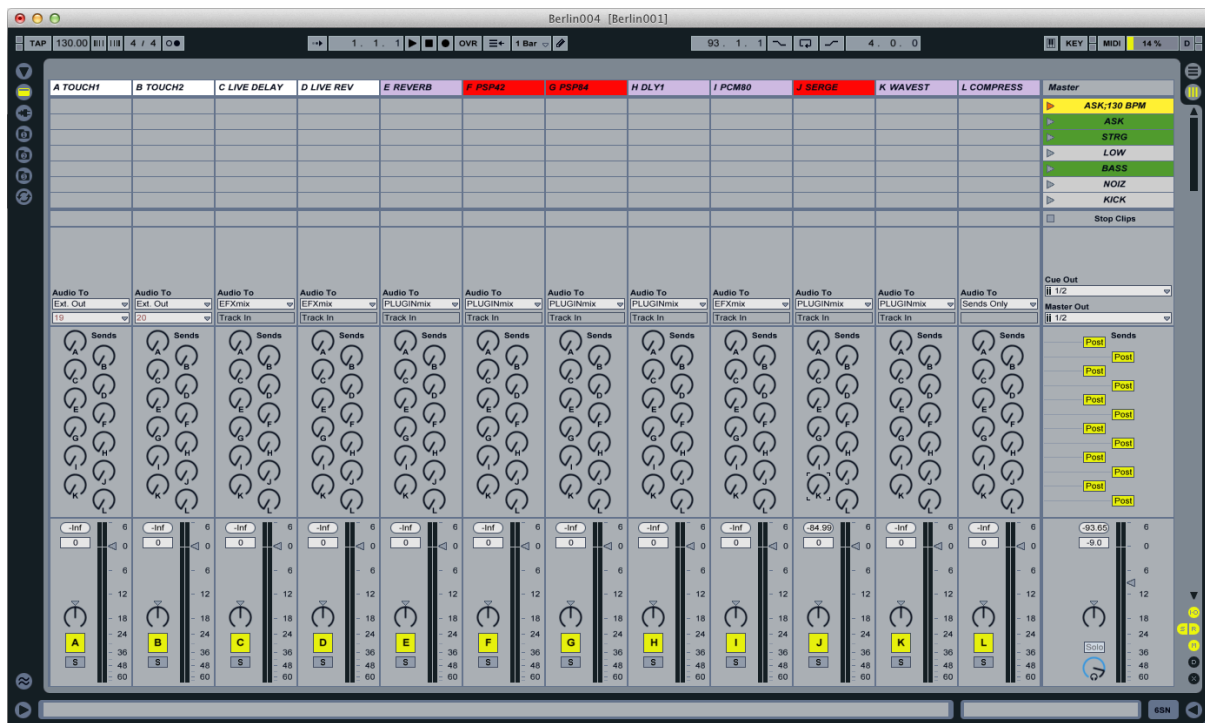


Fig. 10 — Return Tracks

#	Name	Plugins	Output
A	TOUCH1	Sending audio to TouchDesigner visuals software	Hardware output 19
B	TOUCH2	Sending audio to TouchDesigner visuals software	Hardware output 20
C	LIVE DELAY	Lexicon PSP42	EFXmix
D	LIVE REV	Ableton Live Reverb	EFXmix
E	REVERB	Ableton Live Reverb, Ableton Live Flanger	PLUGINmix
F	PSP42	Lexicon PSP42	PLUGINmix
G	PSP84	Lexicon PSP84	PLUGINmix
H	DLY1	Ableton Live Simple Delay	PLUGINmix
I	PCM80	Lexicon LexChamber	EFXmix
J	SERGE	Ableton Live EQ8, SoundToys FilterFreak1	PLUGINmix
K	WAVEST	Korg MDE-X, Korg MDE-x	PLUGINmix
L	COMPRESS	<empty and unused>	<none>

Table 2 — Return Track Effects

Kapture Pad and Return Tracks

The sound palette of Plastikman Live is due to both the instrumentation and the effects processing. The instrumentation, as described above, focuses on the sounds from Roland x0x drum machines. The contribution of effects to the overall timbre is largely created by the interrelationships and feedback between the twelve Return Tracks, each of which contains a different effect plugin.

The first scene of each song contains a clip in the track named “Kapture Pad”. The clip’s name identifies which Kapture Pad snapshot is loaded when the scene is launched. Loading a snapshot correctly sets all the Send Knobs in the Live Set, including all the Audio Tracks and all the Return Tracks, as well as the settings on all the effect plugins and mixer controls, effectively creating a completely different mix for every song. This process enables the show to progress through songs without interrupting the musical flow or requiring Ableton Live to load another Set. It allows each song to have a completely different set of sounds, levels and mix information.

Representing the Return Tracks data

The configuration of the Return Tracks for each song is explicitly listed in a spreadsheet in the ReturnTracksAll.pdf file. The same configurations are also represented in a graphical data visualisation. Both representations can be found in appendix I.

In the graphical representation, the Return Tracks are presented as small squares arranged in a circle. The two output tracks, EFXmix and PLUGINmix, are represented as rectangles at the bottom of the diagram. Each line corresponds to an audio signal flowing from one track to another. The attenuation of the signal is represented by the opacity of the line. The more the signal is attenuated, the paler the line, and the louder the signal, the darker the line. This type of data visualisation is useful to quickly compare the different matrices. The similarity between Matrix 5 and 6 shows how some effect configurations are created from variations and combinations of previous configurations.

Matrix 1: Plasticine, Logikal Nonsense, Slak, Substance Abuse

Matrix 2: Ask Yourself

Matrix 3: Marbles

Matrix 4: Contain

Matrix 5: Synkotik, Ping Pong

Matrix 6: Koncentrik, Kriket, Mind in Rewind, Spastik

Matrix 7: Helikopter

1.2.4 Plasticine

The track 'Plasticine', first released on *Sheet One* (1993), was performed at the Plastikman Live show in Madrid on 29 October 2011. Three different methods are used to provide information about the track. Each of these three different methods provide a

different type of information, each useful in a different way for musical analysis and comprehension.

A recording of 'Plasticine', as performed in Madrid, is included with this thesis (appendix III). A full transcription of this performance, in traditional notation, provides the basis for musical analysis (appendix III). The score demonstrates the repetitiveness within each instrument's part. The rhythmic and melodic patterns within each part are almost static. Development is largely centred on the addition and removal of parts, as well as timbre modulation. A graphical overview of the track (Fig. 11), transcribed in Ableton Live from a recording of the Madrid performance, provides a quick overview of the structure. This graphic, while giving no information about the musical content, places the instruments in the same order as the score and therefore provides an easy overview of the stepped structure. Finally, Table 3 describes how 'Plasticine' is logically sub-divided, and the notable musical techniques used in each sub-section.

Score

I created a score by importing the multitrack audio recording of the Madrid performance. For each instrument, I used MIDI clips from the Session View to match the recorded audio and reconstruct the part. In most cases, the MIDI data and audio lined up perfectly. In a few cases, extra drum fills were found in the recording that didn't correspond to any pre-composed clips. These patterns were played live using the Maschine as a MIDI controller. These fills were transcribed note by note. The MIDI

data for each instrument was then imported in Finale, where I combined instruments in staves and inserted appropriate dynamic and expression markings.

Structure

Table 3, found below, divides ‘Plasticine’ into sections and sub-sections. The score (appendix III) has rehearsal marks corresponding to these divisions. It is important to note that there are no verse/chorus or ABA structures found in ‘Plasticine’. The sections and sub-sections are all different from each other and present different permutations of the same small set of elements. The entry and exit of parts are often asynchronous, for example between sections C4 and D1.

Section	Length	Description
Section A bars 1-4	4 bars	The intro starts with a low F bass pedal that is held for the near totality of the track. A TR-808 conga pattern is carried over from ‘Contain’, the previous track in the show. A field recording of voices and laughter plays faintly in the background.
Section B1 bars 5-12	4 bars	Section B1 begins with the entry of the kick drum. Each subsequent sub-section marks the entry or exit of an instrument.
Section B2 bars 13-22	10 bars	The TR-808 rimshot pattern enters, followed by the snare at bar 15. The modulation of effects on the snare provides motion to the section. This sub-section is the first of several whose length is not an even multiple of 4 bars. This uneven division is due to clips being triggered manually in an improvisatory manner.
Section C1 bars 23-30	8 bars	The TB-303 I pattern enters. The riff is retriggered in a 3+3+2 pattern repeated every bar. As the riff is always retriggered, we never hear the original melody in its entirety as it is heard on the original 1993 release. Modulation of the TB-303 I timbre is one of the main parameters used to articulate the sections. The cutoff is slowly raised and the slides become audible. This is a process similar to Reich’s “substituting rests for beats” (Schwarz 1982). The difference in ‘Plasticine’ is that the TB-303 I substitutions are gradual through timbre modulation rather than through a modification of the pattern.
Section C2 bars 31-46	16 bars	The TR-909 clap enters. The drum pattern and timbre then remain static. TB-303 I is articulated in two phrases of 8 bars each. The cutoff and decay are raised during the phrase until abruptly dropping down at the beginning of the next. Delay and reverb effects are added in the middle of phrases as interjections. The kick drops out for the last two bars, an example of a turnaround often occurring at the end of sub-sections.

Section	Length	Description
Section C3 bars 47-60	14 bars	The TR-606 closed hihat enters. The TB-303 I modulations are divided in two phrases of roughly 6 bars and 8 bars. The cutoff is raised during the first phrase and falls suddenly at the beginning of the second. Reverb is added suddenly at bar 53, marking the beginning of the second phrase. Four bars of a vocal sample, "It's you", and the kick dropping out for one bar mark the turnaround.
Section C4 bars 61-76	16 bars	The TR-909 open hihat enters and the timbre of TB-303 I drops to a low cutoff. Reverbs and delays are used to create motion in the TB-303 I. The overall direction of the TB-303 I is to mute its timbre, in preparation for the entry of TB-303 II in the next section. An interesting aspect to note is the kick turnaround that occurs four bars before the start of the next section. On several occasions Hawtin deliberately desynchronizes the turnaround and the entry of a new part.
Section D1 bars 77-92	16 bars	The second TB-303 enters playing a 5/16 pattern. The pattern is based on a melodic inversion of the TB-303 I riff. TB-303 I is panned slightly left, while TB-303 II is panned slightly right. Additionally, while both TB-303s are in the same register, the first is set to a saw wave whereas the second is set to a square wave. The first two notes of both TB-303 patterns, a staccato E3 followed by a slurred E3, bounce off each other in a polyrhythmic cycle. The two TB-303s are in phase every 5 bars. This is a technique reminiscent of West African music.
Section D2 bars 93-112	20 bars	Whereas previous sections rely on TB-303 modulations to create movement, this section begins by keeping the TB-303's timbre static for 10 full bars. During this time, interest is sustained by various drum variations. Using the Maschine as a MIDI controller to improvise, Hawtin plays TR-808 Congas (bars 94-95) and TR-909 Clap fills (bars 95-98, bars 105-109) before bringing in the TR-909 Ride (m. 100).
Break E1 bars 113-125	13 bars	The break is divided into two sub-sections for a total of 24 bars. The break is announced by the removal of the kick drum and a single instance of the "It's you" vocal. The first sub-section simply fades the two TB-303s and the Synth Bass out, pauses for a few bars, then fades them back in a different order. For the first time in the track, the TB-303 II ends up playing without the TB-303 I. This is a unique moment in the track, as crescendi and decrescendi are otherwise hardly used.
Break E2 bars 126-136	11 bars	The second sub-section of the break is a crescendo built with clap and snare rolls, a very loud TB-303 sample from the original recording, as well as a gradual increase of the TB-303 II's timbre to its maximum cutoff.
Section F1 bars 137-149	13 bars	In this section, the 5/16 TB-303 II pattern can be clearly heard cycling against the quarter note kick drums. The TB-303 II's timbre is gradually muted over the entire section, making room for the re-entry of the TB-303 I in the next section. Asymmetric phrase lengths are again clearly evident as Hawtin brings in a new part, the toms, for the last 5 bars of this section.
Section F2 bars 150-157	8 bars	The TB-303 I returns, announcing the beginning of the finale. The closed hihat enters simultaneously, suddenly raising the energy level. Clap fills mark the turnaround (bars 156-157).
Section F3 bars 158-177	20 bars	The finale is structured in a long crescendo, beginning with the entry of the TR-909 hihats. The timbre of the TB-303s is kept static, presumably because Hawtin is busy working with the drums. An aeroplane sample plays two crescendi, synchronised to whole notes (bars 166-169). Finally, snare and clap rolls mark the final gesture of the track (bars 169-177).

Table 3 — Plasticine Sections

Graphical overview

This graphic below provides a clear view of the staircase structure used to divide sections and sub-sections. It is also easy to see the desynchronised entries mentioned, for example, between sections D1 and D2.

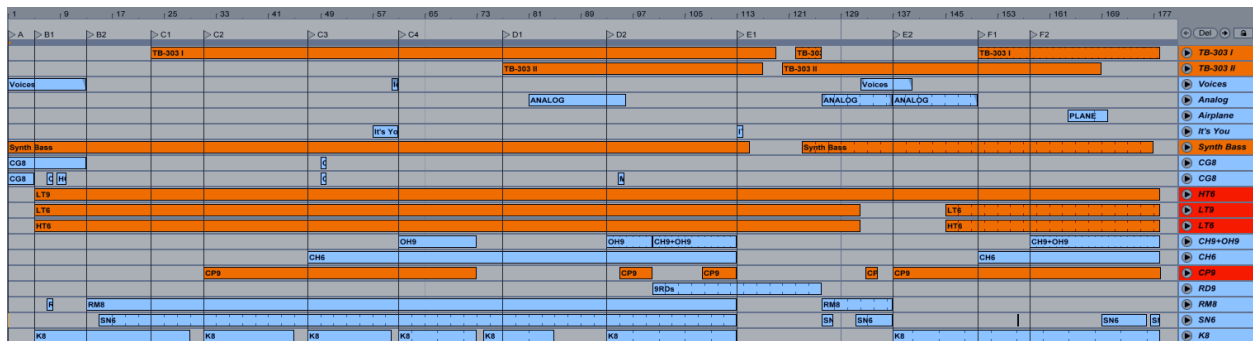


Fig. 11 — Plasticine Arrangement

Improvisation

The Plastikman Live Set is a collection of possibilities composed of four dimensions: clips, scenes, synthesiser parameters and effect controls. The MIDI clips contain a great deal of musical content, the patterns from the original recordings that were painstakingly transcribed for the live tour. Hawtin tends to proceed through the Live Set in an organised fashion, scene by scene. Each scene triggers a group of clips which correspond to a new section or sub-section of the song. As described in the technology chapter, the visible configuration of clips and controllers is automatically rearranged for each song, therefore reducing the number of potential combinations to

only those pertinent for each song. However, as noted in the section-by-section descriptions, one element of improvisation involves asymmetrical section lengths. This means Hawtin sometimes triggers individual clips, rather than the whole scene. The incidental samples are triggered in an ad-hoc fashion. The drum fills are programmed on the spot with the Maschine controller. These spur-of-the-moment gestures are made possible both by the work that went into preparing the Ableton Live Set and the effort made to create the Griid controller.

A second element of improvisation involves the timbre. The modulation curves for the TB-303 synthesis parameters and the amount of effects applied to each part were not explicitly notated at any time, neither during the show's preparation or during the tour. This is a space for improvisation, within set parameters, that draws on Hawtin's virtuoso knowledge of development and change within EDM. The timbre of the TB-303 is often teased open and closed during a section, raised towards the end of a phrase and brought back to a closed sound at the beginning of the next section. The beginning of a new phrase will then often coincide with the entry or exit of a part. In the case of 'Plasticine', the parameters manipulated most often are the cutoff and decay of the TB-303s, as well as the delay and reverb bus effects on the snare, clap and TB-303s. Unlike 'Spastik', for example, 'Plasticine' does not rely heavily on the modulation of drum synthesiser parameters. The timbre of the drums is virtually static, whereas 'Spastik' is entirely focused around the modulation of its TR-808 snare.

As Hawtin explains, he considers his preparation to be focused entirely on the technical structure: “Whenever I’m doing Plastikman or changing something in my DJ set, I very rarely practice. My practice and testing is making sure that I know it all works [...] When I was sitting here doing all the testing and everything, I wasn’t sitting here performing songs“ (Hawtin 2012). The Plastikman Live show did improve with time however, and this studio work, the endless tweaking of the Live Set in hotel rooms, along with the shows themselves, amounts to massive amounts of practice. The show improved and changed very much over its nearly two year long run.

Plastikman is music improvised through the combination of pre-composed parts, and the modulation of the mix. The level of complexity increases with each subsequent level of structure, from a single instrument to a section, from a single section to a song, from a single song to multiple songs, culminating in the entire Plastikman Live show. Every single Plastikman track can be seen as a snapshot from a continuous process. A recording from a particular show is a fixed artefact, whereas the performance setup is a set of tools that allow an infinite number of performances. Plastikman Live presents an interesting balance between pre-composed materials and live recombination.

Historical links

There are many musicological links between 'Plasticine' and previous minimal and non-western musics. Satie is famous for piano miniatures based on simple materials, static formal development and an implicit focus on timbre. The musical materials in Plastikman Live are equally simple, the development is based on staircase shapes of adding and removing clips, and timbre is a central musical parameter. A technique similar to Reich's substitution of rests for beats is used in the development of the TB-303 lines. The influence of West African music is clear both in the polyrhythmic interaction of the two TB-303 lines, as well as through the way different parts complete each other to form new resulting patterns. Various samples are used in a manner reminiscent of musique concrète. Finally, the emphasis on filter sweeps in the TB-303 lines and the manipulation of bus effects is borrowed from dub.

Some elements of a piece like 'Plasticine' offer space for improvisation within certain boundaries, an approach pioneered to different degrees by American classical minimalists. While the rhythms and melodies of 'Plasticine' are completely pre-defined, as in Terry Riley's *In C*, the pacing of the performance and the combinations of cells are open to interpretation. The premiere performance of Plastikman Live was relatively slow, lasting nearly 80 minutes, whereas subsequent shows sometimes clocked just under 60 minutes. This was due not only to pressures from promoters to respect the schedule, but also due to Hawtin's increasing ease with the system.

The performance of 'Plasticine' ends abruptly, as did many classical minimalist pieces from Reich and Glass. This suggests an open sense of time, where the music represents a window into an eternal process. Poschardt describes DJ performance as the "endless peak of dance beats" (1998, p. 162). 'Plasticine' is a clear example of music based entirely on dance beats, structured in continuously ascending peaks. Nearly every section ends with a high and drops suddenly to mark the beginning of a new section, which then starts to build up in intensity.

Technological and commercial links

Hawtin's improvisatory and recombinant approach in Plastikman Live can be linked both to the growing market for music sold in parts, as well as interactive music software such as the Remiix iPhone apps released by Liine.

Delivering music in parts appears to be growing in popularity. Beatport, the leading online store for EDM, has a growing section called "DJ Tools" where tracks are sold in component parts. For example, a customer can purchase the synthesiser part from a Dubfire track, an accapella from Get Physical records and then combine the two in a DJ set. The SoundsToSample.com site advertises over 500,000 loops sorted by sub-genre of EDM. These sounds can then be used by producers in their tracks and performances.

In the Remiix series of iPhone apps, Liine created a simple system where music fans can play songs in a non-linear fashion. By removing the hurdle of learning Ableton Live

and audio editing, we attempted to deliver the experience of performing electronic music to a non-technical audience. Remiix apps are essentially a miniature version of an Ableton Live set, where each version of Remiix packages the sounds from a different artist.

Further links

In Plastikman Live, and particularly 'Plasticine', we see how the music is improvised through a combination of small repetitive musical segments. This approach has recently been adapted for commercial purposes in outlets such as Beatport, SoundsToSample.com and Remiix apps. In the next chapter, we will turn to a broader study of the links between EDM, technology and money.

1.3 Political Economy

This chapter aims to determine some of the relationships between EDM and money, as well as between EDM and electronic communication. Studying these issues contributes to an understanding of why people produce and consume EDM.

One of the main texts used as a theoretical background is Attali's *Bruits: Essai sur l'économie politique de la musique* (2001). A summary of this text will help establish the links between techno music, technology, people and money. Attali's comprehensive history of Western music considers music not only as a reflection of power structures, political ideology and economic organisation, but as a precursor of changes within those aspects of society. He proposes that a music system, an intangible domain of pure signs, can be explored to the limits of its boundaries much more quickly than the tangible systems of economics and politics, which must organise physical objects and people. Therefore, he proposes, developments in musical activity often foretell changes in larger structures of society. "Chaque code musical s'enracine dans les idéologies et les technologies d'une époque en même temps qu'elle les produit" (Attali 2001, p. 21). *Each musical code both grows from, and produces, the ideologies and technologies of its time.*

Attali explores the ramifications of music as a prophetic activity, and some of his own expectations of the immediate future turn out to have been prophetic as well. It is an ambitious position that Attali takes when he predicts future developments and,

fortunately, as the first edition was published in 1977 and translated to English 1985, a certain number of his statements regarding the future can be verified. A second edition, entirely re-written, was published in 2001. In the meantime, access to the Internet had become widespread and notions of copyright and music recordings underwent revolutionary changes. Attali found himself positioned to comment on his own visions. Furthermore, he spoke at length on *Bruits* again at *La Semaine du Son 2012* conference, nearly 35 years after the original publication. His outlook on our relationship to recorded music at present is bleak. He views music recordings as stockpiled time. As such, Repetition is about expending effort to stockpile time recorded by others and obtaining joy from silent accumulation. The future he envisions is optimistic: the era of Composition heralds a musical utopia of obtaining joy from making and sharing music, activities divorced from commercial exchange.

Attali divides music history into four periods, naming them Sacrifice, Representation, Repetition and Composition (any further use of these terms with capitalisation refers to Attali's theory). Each of these periods corresponds to a different type of relationship between music, musician, money and power. Hyper-Repetition, which I have added, occurs simultaneously to Composition. While Attali's theory provides a framework to understand the music project Plastikman and the software company Liine, the activities of Plastikman and Liine provide examples to confirm or refute certain aspects of Attali's theory.

1.3.1 Sacrifice

The act of sacrifice is often violent, and its nature is usually religious. As Attali and Rietveld both use the word sacrifice as a central element of their respective theories, it is worthwhile to examine the different connotations of the term. At the root of Attali's theory is the idea that one of the fundamental roles of music is to act as a simulacrum of ritual violence, and in this role music reinforces social order. It is not necessary here to study ancient societies and the role of musical or religious ritual in organising those same societies, something beyond the scope of this thesis, but merely to consider the premise that music is a core part of religious ritual and that ritual sacrifice is an archetype that is no longer practiced in a literal sense.

As supporting evidence for a link between power, violence and music, Attali cites, among many other sources, ancient myths such as Ulysses and the Sirens and the Pied Piper of Hamelin, as well as direct quotes from the sages.

Sacrifices and music, rites and laws have one and the same goal; it is through them that the hearts of people are united. Sun Ts'ien (*ibid*, p. 57)

To say that there is music, do you think it's necessary to bring pantomimes to defined area, to sound bells and play drums? Keeping your word is a ceremony. Acting without effort or violence, that is music. Confucius (*ibid*, p. 59)

Nowhere can you modify the laws of music without simultaneously modifying the most important civil dispositions. Plato (*Ibid*, p. 53)

Attali states that during the Sacrifice period of music, musicians are “slaves, educated princes or priests” (*Ibid* p. 60). Rietveld describes the DJ as a shamanic figure leading participants on a potentially spiritual journey, where the individual is sacrificed and, in communion through technology, is reborn as a cyborg (Rietveld 2004, p. 53).

Unlike raves, which may have an overt spiritual orientation, as demonstrated by their use of altars, ceremonies and a mix of all kinds of imagery borrowed from sources such as Hinduism, Buddhism, Judaism or UFO cults, a Plastikman Live show does not explicitly demonstrate any spiritual intentions in its format or imagery. If anything, the imagery is abstract and reminiscent of Op Art, minimalist art and the visual distortions of hallucinogenic drugs associated with EDM such as LSD. Nevertheless, a certain form of religious structure is created and experienced, if only for the duration of the show. The physical layout used for a Plastikman show or an event hosting a Richie Hawtin DJ set is reminiscent of a spiritual gathering, a gigantic crowd is amassed in front of an elevated temple-like platform upon which a priestly caste and its assistants work, and the crowds of people answer the call to assembly and gather so that all of them together can get out of their minds and into their bodies (Till 2011). At Time Warp 2012, again in Mannheim, I witnessed a pair of revellers wearing body-length white gowns with a message in bold uppercase letters printed on the back: “TECHNO IS MY RELIGION”. Hawtin describes his role as a leader, or of “master drummer” (St. John

2009, p. 23), in simple terms: “I was an introverted nerd who was, like, I like being in the DJ booth because I was in control of the people and giving them a fun time” (Interview with Hawtin 2012).

Through his study of raves, Robin Sylvan raises points that are key to understanding “the dynamics of a wide variety of other innovative new spiritual and religious phenomena” (Sylvan 2005, p. 9). A few of them seem to support the perspective of the techno event as religious experience and suggest that Plastikman be seen as a priest conducting a ritual and leading dancers on a journey. One of these is the “emphasis of experience over content” (*Ibid* p. 11). Plastikman explicitly references LSD. The cover art for *Sheet One*, for example, was printed on a piece of cardboard resembling a sheet of blotter acid. This blotter emphasises the importance of being out-of-mind. The acid experience is at the very roots of Plastikman. In a scene describing the beginnings of Plastikman, Hawtin and his friends “would finish all-nighters with the whole group lying on the ground listening to ambient music”. Then, says Hawtin, “the acid still tingling in your fingers and toes, you would lie there and become one with the floor” (Hawtin & Sherburne 2011, p. 14). It does not matter that techno as a spiritual experience is not attached to a larger framework within which the dancer should lead his or her life, because “popular religion is thus no longer defined in terms of sustaining traditions, but in the qualitative meaning of the nature of experience” (Sylvan 2005, p. 11). The stripped back materials of minimal techno invite the listener to become synchronised with the rhythm, to become entranced through body movement in time with the music and other dancers. Technology is omnipresent, not only in the DJ booth but also in the

dancers' hands with smartphones recording the event or, in the case of the SYNK app, interacting directly with the performer's music gear. The SYNK app, developed by Rob Fischer, enabled two-way communication between the stage computers and the audience's mobile devices. During key moments of the show, audience members could watch information from the Live Set on their iPhone or remotely trigger samples in the Ableton Live Set. Through the increased use of technology, the crowd and Hawtin become one cyborg body of moving people.

Viewed through Attali's Sacrifice period, a minimal techno event such as Plastikman Live is a ritualistic event. The musician performs music as a group leader. Dancers consume music as part of a transformative experience. Electronic communication is conducted in real-time, through site-specific technologies such as Ableton Live, Grid and the SYNK iPhone app.

1.3.2 Representation

In order to understand the relationship between EDM and money, it is useful to briefly summarise the transformation from Sacrifice to Representation, which is characterised above all by the fact that music gained an exchange value. The transformation was accelerated by the advent of printed sheet music in the 16th century and the emerging seeds of copyright laws in the 18th century. At the same time, in Representation, a new

relationship is established between a musician and his audience. A minimal techno event offers a unique variation on this relationship.

According to Attali, when musicians no longer offered themselves as servants but exchanged their music for money, they assumed a significant new role in society. They became representatives of an idea, specifically that the world can be harmonious and ordered through “commercial exchange and the progress of rational knowledge” (Attali 1985, p. 46). The representation of this idea is musically embodied in Rameau’s theories of harmony. “Elle [la musique] devient monologue de spécialistes en concurrence devant des consommateurs” (Attali 2001, p. 76). *Music became a monologue of specialists competing for an audience.*

Among the first European musicians to charge money for admission to a concert were minstrels, in the 14th century. In the late 17th century, the English violinist and composer John Banister gave the first public concerts of instrumental music (*Ibid*, p. 84). Over the centuries, just as the monarchy had before them, members of the bourgeoisie hired musicians to elevate their own status. Musicians wrote elaborate dedications to their patrons as prefaces to their compositions. As the monarchy lost power to the bourgeoisie, a curious phenomenon occurred: princes aspired to virtuoso levels of musicianship, and often attained it, as if making a last, desperate attempt to retain the power over music. Thus began the transformation of music into a commodity to be bought and sold.

The star system emerged in the 19th century, when economic growth generated a larger number of wealthy spectators with disposable income that they could spend at an ever-growing number of concerts. Concert promoters were in competition with each other and as the century unfolded, an increasing number of virtuosos appeared, in part as a result of these financial conditions. Performance tours became a main source of income, a development that many composers such as Chopin and Berlioz resented as degrading (*Ibid* 2001, pp. 119-130).

The dynamics of the late 20th and early 21st century are quite the opposite. Fame and stage performance are now framed as highly desirable. *American Idol* and its imitators provide an extreme example (Kaufman 2010). Young musicians, DJs and producers work very hard for many various reasons, one of which may well be the reward of fame and stardom. Of course, the exact form that fame and stardom take may vary greatly from one scene to another, whether pop music, commercially successful techno at the level of Richie Hawtin or local underground EDM scenes. In each case, however, the underlying theme is the same, that of the commodification of stardom. Dyer and McDonald go into depth into this topic in *Stars* (2008), as does Morin in *Les Stars* (2005).

The relationship between techno and Representation is more complex and intriguing than Attali makes it out to be. He succinctly dismisses techno: “Derrick May, Carl Craig, Jeff Mills font ainsi danser une jeunesse aussi têtue que désespérée, qui refuse d’admettre ou simplement de regarder le monde” (Attali 2001, p. 187). *Derrick May*,

Carl Craig and Jeff Mills thus make the youth dance, a youth that is as stubborn as it is desperate, which refuses to admit or to even simply look at the world. Such a pejorative oversimplification is reminiscent of Adorno's unforgiving criticism of jazz and popular music, which he described as soulless and decadent (Adorno 1936). Techno demonstrates a particular relationship to live performance, which distinguishes it from previous genres of popular music. Hawtin describes this transformation:

I think there's a heritage there that maybe is missing with the kids of today who are getting into electronic music. They see this big thing, they see us on big stages, it's more rock and roll, they want to be there in front of the people. That wasn't our, my idea, that wasn't why I got into this. I think Plastikman bridges back to those earlier times and this is what I was getting at. All other musicians, pianists or rock musicians, they all went on to the stage in front of the people and played. They were always the centre of attention. That is what it was built upon. Our music wasn't like that. Look at any of the music journals about electronic music in the nineties. It was always called techno the faceless music. Nobody knew what Jeff Mills looked like, didn't know what I looked like. (Hawtin 2012)

Hawtin is describing the fact that he, along with his contemporaries of techno's second wave, were initially attracted to a style of stage performance that went against the star system. I contend that this style of performance, along with the use of music recordings as a tool, clearly indicates that early techno was making a break from Representation, and heralding the Composition period where music is experienced primarily as self-expression. Hawtin and his contemporaries were among the first

bedroom producers, anonymously making music with few resources away from the music industry, pioneering the role before the World Wide Web even existed.

Dancers at early disco, house and techno events, by facing each other, were marking a break from the social dynamic of concerts. However, as Hawtin observed, crowds soon started facing the DJ. Since then, techno events have become more of a show where DJs are players in the star system who represent ideals and ideologies, which audience members reinforce by their presence. A traditional dynamic is somehow reintegrated, minus the silent reverence of bourgeois concerts. In spite of facing a star on stage, the audience is not passively consuming the music. The audience is actively participating by dancing.

1.3.3 Repetition

Two aspects of Repetition merit focus in the context of this chapter: the notion of recording sound and that of repetitive procedures in music composition. Recording technologies were invented and introduced to the world on the cusp of the era of mass production. Repetitive procedures in music composition, as ubiquitously exemplified in classical minimalism, can be understood to a certain degree as being a consequence of recording technologies. Both of these aspects are at the very core of the nature of techno. Techno appeared on the scene at a time when recording technologies and repetition in composition were firmly established. Techno champions a new relationship to recordings by using recordings as base materials for a performance, in other words

“mixing [...] two records to effect the creation of a third thing” (Poschardt 1998, pp. 32-33). Two innovations define the era of Repetition: recording technologies and mass production.

Recording technologies and mass production

Attali's Repetition period deals with the significance of music recordings as objects of mass consumption. In his description of the mid-19th century precursors to Edison's phonograph, Attali points out that the act of measuring sound in an effort to transcribe and transmit it over distances is essentially inseparable from recording. He gives as examples Morse code, Braille and the standardisation of concert pitch. “L'un et l'autre supposent la transformation du son en un ensemble de signes” (Attali 2001, p. 146). *Both support the transformation of sound into a group [ensemble] of signs.* This idea comes full circle when, in the 21st century, we arrive at a point where recordings, once immutable accounts of performance, can be broken down into hundreds, even thousands, of little segments in an Ableton Live set displayed as a collection of visual signs representing musical sounds on an iPad by Grid or Remiix software. Recording technology was developed to transform sound into an ensemble of signs. Modern technology can accomplish the opposite by transforming an ensemble of signs into sound.

In 1890, after recording technologies first became commercially successful, Edison wrote an article describing in great detail the breadth of its applications (Attali 2001, pp. 151-152). The article turns out to be an exhaustive and rather accurate list of the usage

of recording technology for the next 100 years, such as audiobooks, music, voicemail, lectures and dictaphones (Attali 2001, pp. 151-152). It is perhaps no coincidence that the aesthetic roots of minimalism can also be traced to the late 19th century with the music of Satie. At the roots of minimalism, there is a synchronicity between the development of technology and musical aesthetics.

Early in the 20th century, the mass reproduction of recorded sound formed the basis of a new industry. Music became pure sounds excised from ritual and performance, disconnected from a specific time or place. From a financial point of view, live performance became a means of selling recordings. Musicians on stage were no longer actors representing an ideology, but salespeople serving the needs of record companies. The advent of recordings in popular culture created the oppositional notion of 'live music'. Without the distinction between live and recorded music, there was only music performance and sheet music. Music is now conceptually divided into three: live music (Sacrifice), sheet music (Representation) and recorded music (Repetition).

Recordings first gained legitimacy in art music as instruments that could be used in performance as early as 1939, with Cage's *Imaginary Landscape no. 1*, which features a scored part for record player. The general use of recording technologies in musique concrète confirmed their acceptance. Schaeffer's *Traité des Objets Musicaux*, a text on the perceptual analysis of sound itself rather than its notated representation, was first published in 1966. Records, as an instrument in popular culture, gained authenticity soon thereafter. Outside isolated examples of sampling and tape music such as The

Beatles' *Number 9* (1968) or Pink Floyd's *Dark Side of the Moon* (1973), recordings acquired the status of instruments in popular music towards the late 1970s. This demonstrates how quickly the ideas surrounding recording technologies became democratised and spread from academic research to popular music. First with disco edits and Caribbean soundsystem culture, and then later with hip-hop and techno, recorded sound started to serve as source material for a performance. What Pierre Schaeffer and Stockhausen did painstakingly in studios, creating recombinant tape edits of recorded sound, whether concrete or synthesised, DJs do in realtime with turntables, samplers and later, a vast assortment of digital technologies which now includes iPad controller apps.

Recombinant edits are now created in realtime on an unprecedented scale in Plastikman Live. The original tracks were recreated, broken down and organised in parts as small as the basic units of phrases, bars, sonorous gestures and single sounds. At that point the use of recorded sound has moved beyond the confines of Repetition and has been entirely appropriated as basic units, a vocabulary for improvised live performance.

Repetition through composition technique

In *Repeating Ourselves*, Fink examines how 1960s minimalist music echoes the discourse of advertising. He is quick to point out that in a culture of repetition, repetitive music “needn’t only represent capitulation to its effects; the work might take on the burden of repetition as commentary, as critique, even as a kind of calisthenic

mental toughening” (Fink 2005, pp. 66-67). Indeed, as we have seen, the example of the dance experience and the idea of pleasure derived from controlling machines of repetition, repetitive music has the capacity to cast very different meanings on repetitive culture.

Along with disco, one of the direct musical antecedents of techno is classical minimalism, for example in the works of Terry Riley, Steve Reich and Philip Glass. Fink proposes a compelling theory of classical minimalism as a reflection of both mass production of products and mass production of desire. Yet, classical minimalism equally reflects the structures of non-Western musics such as Indian Classical music, Balinese and Javanese Gamelan, as well as West African drumming. He frames classical minimalism as the musical embodiment of global media culture, the principal discourse of which is advertising. This theory helps clarify the commercial nature of techno and digital EDM. To make his case, Fink makes a comparison between Perec’s novel *Les Choses* (1965), supermarket shoppers entranced by rows of products and the effect of Steve Reich’s pulse pattern music.

The first example, Perec’s novel, is described by Fink as “an extended descriptive rhapsody on consumer desire” (2005, p. 101). The climactic scene is full of metaphors invoking great speed and vast distances, and the characters’ experiences are described as overwhelming, fleeting, ephemeral and fragile. “As Sylvie and Jérôme sit down to consume dinner at a local bistro, they experience ‘an almost visceral pleasure, a pleasure so intense as to verge on numbness: an impression, almost exactly

opposite and almost exactly identical to the experience of speed” (*ibid*, p. 104). As a second example, Fink describes the mild state of entrancement experienced by a shopper going down the aisles of a supermarket: “she finds the repeating pattern of the coloured labels vaguely relaxing as she glides by. (Clinical monitoring of her eye-blink rate would show that she has entered the first stage of hypnoid trance)” (*ibid*, p. 2). The third example is the structure and effect of Reich’s pulse-pattern minimalist music, specifically how it simultaneously deals with both fast and slow rhythms. As he puts it: “there is no art form better at conveying that complexity of experience than music [...] no genre of art music is more concerned with interpenetrated extremes of temporality than pulse-pattern minimalism” (*ibid*, p. 104).

All three examples deal with overloading the senses by means that Fink qualifies as kaleidoscopic, isomorphic, hallucinating and especially *fast-yet-slow*. A similar *fast-yet-slow* dual-layer of temporality is exhibited in techno. On a micro scale, techno is very fast. The tempo is at least 120 BPM and the feel is busy. It is common for every sixteenth note to be articulated. On the macro scale, DJ sets and techno events move at a very slow pace. It is not difficult to appreciate the sensory overload effect when the size of the Plastikman Live Ableton set and the Beatport catalogue are taken into consideration. Beatport, an online store that sells EDM recordings in the form of MP3 or WAV files, offers a catalogue numbering hundreds of thousands of tracks. The amount of information is staggering. While Terry Riley’s minimalist composition *In C* (1964) is structured around 53 short, interchangeable musical fragments, the Plastikman Live set is a grid containing thousands of potential musical fragments.

I propose that global techno production can be seen as an exaggerated reflection of the structures of mass production and mass consumption. This relationship between music and ideology is enabled by the digital revolution. Inexpensive software combined with Internet access enables a fragmented global network of enthusiastic producers the opportunity to recreate infinite variations for Beatport's financial profit, thus creating a digital, accelerated version of Repetition. Regardless of the motivations of techno's originators and present actors, the global techno scene reflects larger structures of power that organise society. The crowd is facing a superstar DJ on stage who represents the ideology of mass consumerism in his role of a professional consumer of commodity recordings, an enhanced cyborg shamanistically transforming minimalist musical representations of mass production into rituals of loss and transcendence. Simultaneously, as will be seen further on, the same superstar DJ can be seen as an actor of Composition.

The link between structures of consumer desire, production and composition techniques is but one of the two keys to understanding why techno can be seen as an embodiment of Hyper-Repetition. The other key is how techno is distributed. According to Attali (2001, p. 248), widespread access to the Internet, along with the democratisation of digital technologies, could herald the era of Composition based on free exchange. But, as is apparent by the scores of producers involved in constantly renewing the collective stock of commercial content, the Internet also simultaneously enables the era of Hyper-Repetition.

1.3.4 Hyper-Repetition

In the context of this thesis, the digital revolution is focused upon two sweeping changes that began in the late 1990s: the democratisation of digital music technology through affordable software based recording studios and widespread access to the Internet. Although some EDM labels continue to release music on vinyl, sometimes exclusively so, the majority of EDM producers and DJs create, distribute and play digital music. The digital revolution effectively creates the possibility of Hyper-Repetition, music as an infinitely reproducible virtual object, whose accumulation is limited only by the amount of disk space available on the planet.

The very technologies that offered affordable digital computers to produce tracks, and the Internet to reproduce them at a negligible cost, now also enables a fragmented global network of enthusiastic producers the opportunity to recreate infinite variations for Beatport's financial profit, thus perpetuating an aspect of Repetition, the previous mode of organisation. Beatport can be seen as a decentralised, planet-wide Tin Pan Alley (Suisman 2009, p. 41) that enables the manifestation of Repetition unfettered by the many restrictions associated with creating, distributing, storing and selling physical media. The digital revolution enables a proliferation of production, which consequently causes the sale value of recordings to collapse, and thus heralds the possibility of entirely new modes of organisation which depart from the 20th century of repetitive consumption. However, we have not yet come to fully embrace these new modes of organisation, at least not in the field of EDM.

The proliferation of producers working in a specific genre, producing innumerable variations within a sub-genre, does offer benefits. From the perspective of the individual musician, collective repetition can be understood as “looking for the perfect beat” (Afrika Bambaataa 1983). Chernoff’s description of the evolution of a style, from one generation of musicians to the next, could be just as easily be transposed to the evolution of classical music between Mozart and Beethoven, or the evolution from techno’s first to second waves. “Musicians and musical associations introduce slight innovations with the idea of doing something a bit new with the same thing” (1981, p. 65). Berlin-based EDM sociologist Jan Kühn finds a similar pattern when describing producers’ work: “the normative core of the scene economy lies in the *creative nub* [...] the typical as the usual product of the scene with a slight peculiarity, deviation and idiosyncrasy” (2011, p. 3). Berlin-based producer Anna Bojadzhieva (personal communication, 24 April 2012) suggests that, since communities of producers are physically distant, “the recurrence of slightly deviated, yet formalised patterns is maybe also an expression for the desire of communion.” Repetition can therefore be seen as a form of acknowledgement between musicians, a means to confirm a common ground and strengthen a sense of belonging.

On the other hand, as Frank Zappa writes, this phenomenon could also be called “Death by Nostalgia”:

The really big news of the eighties is the stampede to regurgitate mildly camouflaged musical styles of previous decades, in ever-shrinking cycles of 'nostalgia.' When you compute the length of time between The Event and The Nostalgia For The Event, the span seems to be about a year less in each cycle. Eventually within the next quarter of a century, the nostalgia cycles will be so close together that people will not be able to take a step without being nostalgic for the one they just took. At that point, everything stops.

Death by Nostalgia. (Zappa 1988, p. 113)

Hijacking Neil Postman's observation of the entertainment-centred culture of the 1980s, "Amusing Ourselves to Death" (2011), it may be said of Hyper-Repetition that we are repeating ourselves to death. It is perhaps principally a matter of taste and perspective whether the repetitive production of similar EDM tracks constitutes a denial of variety, or whether it constitutes an act of solidarity and a sense of belonging between participants of a scene.

Frith divides the history of music reproduction into 'folk', 'art' and 'pop' stages. In the first stage, music is stored in the body through oral tradition. In the second stage, "music is stored through notation" (1996, pp. 226-227). Finally, in the third and current stage, music is stored as recordings, tangible, infinitely reproducible representations of the sound wave itself. Starting with the invention of notation, one could be said to own music. Recordings are now often considered to be the principal focus of music. Quantities of music recordings can be accumulated and considered to be a personal possession. Since the early days of file sharing, it has become quite common to download and store vast quantities of MP3s. Very often a personal library even

contains more recorded music than the individual could ever hope to listen to. Many of those files will never be translated to physical sound waves. This is much more than a wry observation about contradictions in the digital age. Attali is entirely correct to argue that vast accumulations of unsounded MP3 files are not music, but merely the potential for music. In the 21st century, as the novelty of the availability of infinite information wears off, then so does the capacity for obtaining joy from silent accumulation. A streaming service such as Spotify negates the need for accumulation, music is always there. Young people today are growing up in a world where infinite information is a given. If the notion of scarcity and cost associated with music recordings on physical media no longer applies, then an interesting question arises. What is the impetus to accumulate more digital recordings than it is possible to listen to? As the brute acquisition of data loses its appeal, the ability of the individual to filter the global chatterbox according to a set of personal preferences becomes of central importance. The vast amount of music produced in the post-digital era is reflected in the vast amounts of recordings available for consumption. The perspective of the EDM music consumer in the post-digital period is an area that warrants further study.

The concept of Hyper-Repetition explains certain aspects of techno production on a global scale, but it also useful for elucidating aspects of techno production on an individual scale. A commercially successful genre provides producers with a clear context in which to work. A label's sound can serve as a potential blueprint for a producer's work. Constraints, by serving as a formal filtering mechanism, may actually enhance artistic creativity. The French literary movement "Oulipo" (Ouvroir de

Littérature Potentielle), for example, carried the challenge of creative constraints to an extreme. Georges Perec, in particular, is famous for having written an entire novel, *La Disparition* (1969), without using the letter 'e'. Similarly, Christian Bök wrote each of the five chapters of his book *Eunoia* (2001) using only a single vowel throughout. Constraints whittle down the infinity of options to something that is more manageable. Producers with access to production and performance tools such as Grid, Kapture and Lemur, can choose to create a personal set of toolset constraints and challenge themselves in their work. They have the option to seek pleasure through any role they wish to play, be it one supporting the structures of Hyper-Repetition or not.

The technologies of the digital revolution combine with the mode of organisation of Repetition to produce Hyper-Repetition. It is within the framework of Hyper-Repetition that a fragmented global network of enthusiastic producers implicitly work as freelancers for Beatport. In this case, EDM gains exchange value as a mass-produced product. The technologies of the digital revolution simultaneously enable Composition, the period to which we turn next.

1.3.5 Composition

The essence of Attali's Composition period is his anticipation of a new era in which the predominant goal of music is to obtain pleasure from the act of making and sharing it. During this period, music production is divorced from commercial exchange.

Attali sees improvisation as a form of rebellion against Repetition and gives the example of Ornette Coleman's early free jazz experimentations clashing with the demand of the jazz recording market. Tools such as Max for Live, Lemur, and even the home studio itself, offer a deep potential for improvisation. It is up to the individual producer to create and to improvise not only music, but also music-making tools. Hawtin stresses the importance of improvisation, based on a custom set of tools, in his artistic process: "Having a well thought-out setup that invites spontaneity, and you're recording and producing, is at the very heart of what I've always tried to do" (Interview with Hawtin 2012).

In the 2001 revision of his original 1977 work, Attali goes into detail about platforms for freely distributing digital music, commonly known as file sharing, and the efforts expended for controlling those platforms. Control is exerted by both technological and legal means. He uses early peer-to-peer file-sharing systems Napster and Gnutella as case studies. With these decentralised systems, users can anonymously share files over the Internet. Although Napster and Gnutella have long since closed, many others have appeared to take their place. Since the publication of *Bruits* in 2001, iTunes and others have tried, but failed, to permanently impose Digital Rights Management systems on MP3 files. In contrast to the failure of iTunes to impose control, an international police force succeeded in shutting down the popular file-sharing site MegaUpload in 2012, having resorted to guns and helicopters to arrest the owner Kim Dotcom (Diaz 2012). Besides music recordings, MegaUpload was also used for sharing other copyrighted materials such as movies and software. The shutdown, however, is

ineffective. New sites constantly appear and countless others continue to operate, such as Zshare, Hotfile, Rapidshare and The Pirate Bay. The MegaUpload website is now closed and the domain has been seized by the US Department of Justice, the FBI and the National Intellectual Property Rights Coordination Center (NIPRCC). The battles fought to defend copyright have now extended from the virtual to the physical world, a powerful manifestation of the link between music and power.

“Rupture radicale avec le marché, la composition n’en ouvre pas moins aussi un marché pour vendre des instruments de composition” (Attali 2001, p. 253). *Composition marks a radical departure from the market of Repetition, but, at the same time, it opens a new market for music-making tools.* As a result, the role of the musician in the 21st century takes a sharp turn away from the role played in the 20th century. In this light, the relationship between Plastikman Live and Griid, Kapture and Lemur exemplifies the possible role of the stage artist as a salesperson of music-making tools in addition to music recordings. The software company Liine is aligned with Composition, where the commodities are not music recordings but music-making tools, and almost all the people who constitute Liine are either trained musicians or self-taught professional musicians. The democratisation of technology through the availability of tools is at the heart of Plastikman and Hawtin’s identity:

I’m a product of this democratisation of technology, when in the late eighties drum machines and 303s were being thrown away. I was able to buy them cheap, those pieces of equipment that I started to make music on and that I started to perform on. It opened up a door to me that I never thought possible. Two years before I thought I was

going to be going to school for video and film. It's probably even more as I get older I want to enlighten people, the younger generation to that, to follow that kind of lead.

(Hawtin 2012)

It has been possible to observe the realisation of Attali's utopia of Composition since the early 1980s in some underground and mainstream manifestations. Whereas music production previously required expensive studios, starting in the early 1980s, low cost synthesisers and drum machines became available, which meant that electronics could replace the functions of instrumentalists, and could be more easily recorded. As the financial bar for entry into music production was lowered, underground music such as Detroit techno and minimal techno were able to emerge. This trend was further accelerated when in the mid-nineties, advances in personal computer hardware and software made it possible to run low cost software-based audio recording studios. Bedroom producers have taken advantage of this situation and make music at home on low cost equipment, or now simply on their laptop.

The democratisation of production was soon followed by the democratisation of distribution. Netlabels, an early example of Composition, emerged in the late 1990s and usually combined the roles of label, distributor and retailer. A Netlabel would typically be hosted on its own website and would offer original releases as MP3 files. No money was charged for downloads, nor were artists financially remunerated in any way. By the late 2000s, the popularity of Netlabels had waned, often due to the challenges of running an organisation with no budget.

It is important to remember that Attali's utopia of Composition is just that, idealised utopianism. Producing and distributing EDM is possible with very inexpensive technology, but it nevertheless requires a big investment of time and practice. The necessity to earn a living is all too real, as is the challenge to reconcile that necessity with the investment of time necessary for achieving mastery. It is extremely rare for an EDM producer to earn a living directly from sales of recordings. Considering the changing relationship of musicians to money, technology and power over the past centuries, it is well worth considering what the future might hold in store for musicians. In the future, will professional musicians still fill the same roles, as they exist today? If not, how will musicians earn a living? And how will the answers to both these questions be reflected in the rest of society? Potential answers to these questions are discussed in the conclusions chapter of this thesis.

Richie Hawtin can be seen as the quintessential bedroom producer. He is a self-taught musician, he has made most of his music in his home studio, starting with the basement in his parents' house, and he has self-released most of his music. Hawtin describes the Plastikman project in terms of a cage where he was "quite happy to be away from people, twiddling knobs and playing with electronics. That is a cage that I'm quite happy to put myself in" (Hawtin 2012). It is quite the paradox, shutting oneself away physically in a room, alone, to explore new ways of connecting with people. The same paradox applies to contemporary social life when people find themselves alone with technology, connecting to others through email, Facebook and text messaging. The relationship with machines that Hawtin explored through Plastikman, a project

meant to connect to people, was prophetic of the relationships between people in the post-digital era.

Techno, as a faceless music, was futuristic not because it incorporated themes of outer space and extra-terrestrials, but because it embodied future modes of communicating through technology. Techno was a music where, unlike an orchestra or a rock band, you “get some new equipment, close the door and fuckin’ fiddle around and find out what’s inside of you and how that comes through that technology” (Hawtin 2012). Before his present involvement with Liine, Hawtin played a key role in the development of several Ableton Live features and he collaborated with Allen & Heath to customise mixers. Hawtin’s involvement in technology companies Liine, Ableton and Allen & Heath, as well as his relationship to technology as an artist, reflects the dynamics of Composition. Hawtin was one of the first artists to get on board Beatport and recognise its potential. He influenced other artists and labels to join the site and thus made a significant contribution to Beatport’s popular success, reflecting the dynamics of Hyper-Repetition. It is clear that Richie Hawtin has led a remarkable career, but what is particularly remarkable for the purpose of this thesis is how closely Hawtin’s career mirrors the cultural shift from Repetition to both Hyper-Repetition and Composition.

The era of Composition has now emerged in mainstream society through sites such as Bandcamp, SoundCloud and YouTube, to name but a few of the tools available. Bandcamp offers an infrastructure that enables users to easily sell digital music recordings. Unlike Beatport, Bandcamp does not have a centralised store with charts,

it simply offers the tools for users to create their own micro store. SoundCloud allows users to upload any audio files to their public profile. Users can then leave comments on each other's tracks and create relationships based on the exchange of recordings. Similarly, YouTube lets users upload, watch and comment on video files for free.

Music, text, software, videos, graphics and animations can be created at no financial cost. People can upload their digital creations for free and easily connect with like-minded individuals, whether other musicians or simply fans. The time and relationships invested, however, is hardly trivial and raises a serious impediment to the utopia of Composition. In the 19th century, the invention of player pianos enabled people to manufacture music in their homes instead of handcrafting it. Soon thereafter, people started consuming industrially produced music, that is, recordings. Now that the tools of industrial music production are available to all, the opportunity has arisen to not only observe but to actively participate in the changing relationship between people, music, money and technology.

This chapter uncovered three aspects of the relationship between EDM and money, which reflect different aspects of Attali's theory. Producers and DJs act as stars on stage, acting as professional consumers of commodity recordings in a modified reflection of Representation where the crowd is actively participating. Digital technologies such as software synthesisers and online stores such as Beatport enable the mass production and mass consumption of EDM tracks, in a reflection of Hyper-Repetition. Services such as SoundCloud and YouTube enable musicians to share their

music for free, in a reflection of Composition. This chapter also confirmed the ritual aspect of minimal techno events such as Plastikman Live, drawing a parallel between Attali's Sacrifice period and Rietveld's Sacrificial Cyborg concept.

In order to better understand Attali's theory, I explored the ideas raised in the Hyper-Repetition and Composition periods in my music production work. The next chapter describes how I questioned, through music composition, the necessity to conform to the aesthetic codes of a sub-genre, and to the commercial infrastructures proposed by labels and Beatport.

2. Music

This chapter provides commentary on music I produced in parallel to my work with Liine and Plastikman Live. The chapter is divided in eight sections, corresponding to five different phases of music-making, two additional works and a final score. I produced music in reaction to my theoretical research, my work with Liine and my work on Plastikman Live. Different phases of music-making deal with different questions addressed in this study.

The first phase consists of a series of recordings of performances, and aims to answer the following question. How can minimal techno be performed? I created a Live Set from scratch, with new musical materials and a structure inspired by the Plastikman Live set. I then recorded practice performances of this Live Set.

The second phase is eight tracks I produced based on musical fragments and techniques stemming from the first phase. Some of these tracks are exercises in style, emulating techniques from various Minus artists, while others are experiments in process music. The second phase aims to answer the following question. How can minimal techno be produced?

The third phase addresses the following questions. Why make minimal techno? Why make music? I explored through compositional experiments,, the conflict between the commercial reality of EDM production and Attali's Composition period, where the

emphasis of music-making is shifted from commercial exchange to obtaining joy from the acts of making and sharing music. The third phase is therefore an experiment in work methods, a series of 188 miniatures recorded over six months at the rate of one per day. I recorded a sketch first thing every morning as a way to generate material through improvisation.

The fourth phase aims to further explore the potential conflict between EDM production and Attali's Composition stage. I developed selected recordings from phase three into a four track EP including both uptempo and downtempo tracks, a combination commonly found on releases from Traum Schallplatten, a prominent German techno label.

The fifth phase is a final attempt to resolve the potential conflict between commercial music production and Attali's Composition stage. I attempted to create a work ready for public distribution and consumption based as closely as possible to materials recorded in phase three. The result is an album of miniatures somewhat in the style of Zomby, an EDM producer who often produces very short tracks.

The first additional work is three tracks grouped as Extras, resulting from sporadic efforts to complete peripheral ideas generated in phase three. These tracks served as a testing ground for phases three, four and five without necessitating a full commitment to the aesthetic. The second additional work is a DJ set I recorded at an Off Sonar 2012 event where I played many of the tracks from the previous phases. This DJ set

provided an opportunity to answer an important question. How can my compositions be performed if they do not conform to an established minimal techno aesthetic?

This entire process of thought and music-making is summarised in the last work Composition 2012 #1. Inspired by Cage and Young, this score addresses many of the issues with which I had previously been challenged. The score offers a potential answer to the following question. Why make music?

Following the project's completion, a number of tracks were commercially released. 'Ellipse', produced in collaboration with Max Cooper, is based on '111215 the jonsonator' from phase three. The track was released as part of the Movements EP (2013) on Traum Schallplatten (<http://www.traumschallplatten.de/traum/traumv162/traumv162.html>). The track 'Four Synths' from phase two was reworked and will be part of a solo EP on Trapez Recordings in June 2013.

2.1 Phase One

After working with Hawtin and my Liine colleagues for over a year, I began to construct a system of my own for live performance. I worked on this phase from April to June 2011. The goal was to create, like Plastikman Live, an Ableton Set supporting an hour long improvised performance around pre-existing materials. Phase one is chiefly concerned with the question of how EDM can be performed.

Every morning I would create a new set of musical materials in four specific categories: kick drum, bass line, drum loops, synth riffs and ambient sounds. The initial goal was to produce a collection of interchangeable materials over the course of the Monday to Friday workweek, and then practice the performance on the weekends. After several weeks, the collection was sufficiently developed to assemble the interchangeable material into a Live Set so they could be combined through improvised performance.

I set aside time to build the necessary Max for Live plugins necessary for my performance. I practiced playing with the Live Set on weekends, I recorded the performances and took notes for making improvements. I felt uncertain about the structure of this approach and began performing and recording, in addition to creating new materials, every day. The table below lists the date and length of the performance recordings. The recording from May 9 2012 is included with this thesis.

Date	Length
2011/04/09	5'07"
2011/04/17	18'18"
2011/04/25	27'16"
2011/05/01	21'21"
2011/05/02	24'35"
2011/05/04	16'54"
2011/05/09	50'24"
2011/05/10	4'06"
2011/05/11	8'27"
2011/05/12	3'04"
2011/05/13	15'16"
2011/05/14	12'00"
2011/05/15	1'55"
2011/05/22	1'58"
2011/05/23	14'34"
2011/06/11	7'26"

Table 4 — Phase one Recordings

As the weeks progressed, the amount of material grew and the performances, too, grew longer for a time. I soon felt, however, that the approach was somehow systemically flawed. It became increasingly difficult to maintain coherence, the performances dwindled and then came to a stop.

I understood that this system of production was problematic because it fell between two different approaches, without full commitment to either. The first approach would be to start with pre-existing tracks and adapt them for live performance. This was precisely the approach in the case of Plastikman Live, where tracks dating from the 1990s were entirely reconstructed in Ableton Live for the Plastikman Live show in 2010. The second approach would be to create a large amount of small, interchangeable musical materials, drum loops, bass lines and synth riffs, such as those found on sample CDs. I realised I was not basing my work on either of these approaches. I was not adapting pre-existing tracks for live performance, nor was I was creating enough material necessary for an improvisation around small loops. Although I knew that Plastikman was existing music written by Hawtin, I had not fully realised the significance of having existing materials before trying to arrange and perform them with Grid. This realisation led me to abandon the phase one approach.

2.2 Phase Two

While the concern in phase one was how minimal techno could be performed, the focus in phase two shifted to how minimal techno can be produced. Issues relating to working in specifically identifiable sub-genres are discussed in more detail in the context of Hyper-Repetition in the political economy chapter of this thesis. I set out to create a body of music that would serve as a basis for preparing a live performance. The main concern for this phase was how EDM is produced. I selected the most promising materials that I had created for phase one and produced eight tracks in June and July 2011. These are listed below with a short commentary for each.

Four Synths

This track incorporates a custom Max for Live plugin I created to enable a polyphonic delay. The track is based on a process proposed by Steve Reich in *Four Organs* and attempts to fuse this process with the feel from Robert Hood's 'Minus'. A four note staccato chord plays once every four beats. On each repetition, each note of the chord is slightly delayed. The actual delay is different for the four notes. The bass note is delayed the longest, the tenor less, the alto even less, while the soprano note retains the same position as in the initial chord. The length of delay is slowly increased in a controlled manner until the four notes fall exactly on the sixteenths' grid. Thus, a chord is transformed into a descending arpeggio.

Functional Analog

This track is an experiment in producing a track very quickly. I started with a simple acid line and used the performance setup from phase one to improvise a structure. The effects and mixing were recorded in several live passes. I completed the track by fine-tuning certain details in Ableton Live's Arrangement View.

Farbfernseher

The particular significance of this track is its departure from the minimal techno aesthetic. I found it difficult to restrict my work to one sub-genre. Producing commercially viable techno tracks requires the reproduction of an archetype, as described in the theory chapter. *Farbfernseher* was produced with a specific label in mind, one with which I had good contact, but which is far from the minimal techno scene. The advantages of working in specifically identifiable sub-genres are discussed in the Hyper-Repetition period in the theory chapter.

Just Chords

This track, inspired by LaMonte Young's work, was an experiment in just intonation. I concluded that intonation effects are most effective with sustained tones. The short synth stabs in this track are simply the wrong type of musical gesture to showcase stable intervals without beating frequencies.

The Ghost

This track focuses on the use of complex feedback routing on Return Tracks, as in the Plastikman Live set. I often attenuated the original signal of the synths and simply played with the Send knobs on the Return Tracks to create and control feedback. The title of the track refers to this resulting audio, the effected signal is the titular ghost of the original audio source.

Laughing Gas

This track is an attempt to emulate a reductionist style of minimal techno found in some tracks by Marc Houle, a Minus artist, or Tony Rohr, an accomplished American techno producer. I improvised as many aspects of the track as possible, as I did with the track *Functional Analogue*, and I used structures from the phase one performance Live Set. In the course of my interview with Hawtin, he discussed his methods for producing and performing Plastikman, and confirmed the value this improvisatory approach to producing tracks: “What I realised from doing Plastikman Live and especially the live shows is that spontaneity is the key thing you want to capture” (Interview with Hawtin 2012).

Ping Time

This track uses another process borrowed from Steve Reich. I substituted rests with beats in the main synth line, a short bleep sound. At the time, Liine was busy prototyping a new module for Griid called Cliip. This new module allows the musician to draw directly on the piano roll grid from the iPad. I used Cliip to improvise the

sequence in 'Ping Time', adding a note every 8 bars. Every arrangement of 'Ping Time' was different and performed in one take. I then selected my favourite recording and polished it in the Arrangement View.

Silkworm

This track is an exercise in style based on on two Minus artists, Gaiser and Marc Houle. I imitated a style of portamento bass line found in early Gaiser tracks such as 'Ciliate With'. These tracks use pitch bends that create a particularly blurry sense of tonality. This allows any type of material to be played on top without clashing harmonically. I borrowed from Marc Houle his reductionist approach to drums, using a bare pattern that consists of only a kick drum and a snare.

After completing these tracks, I hesitated to send them to labels. The tracks felt like outsider exercises in style rather than authentic insider archetypes. Stephan Bodzin, a well established German producer of melodic minimal techno with whom I maintain a good professional contact, was initially enthusiastic about releasing these tracks, but later retracted the release offer. I did not feel that the tracks were aesthetically appropriate submissions for Minus, and so I did not submit them to Hawtin. I was satisfied with the learning process, but unsure about the overall aesthetic direction of my sound. My hesitation to push the tracks to more labels, as well as the eclectic styles produced, were both reflections of my ambivalence.

2.3 Phase Three

Phase three coincided with my work on analysing Attali's theory. I was interested in exploring his Composition period through a practical process focused on realtime music-making, as opposed to the creation and distribution of recorded artefacts. The third phase of music-making also addressed two unresolved issues raised in the previous phases. From phase one, I learned that an improvised live performance requires a large quantity of material, whether those are based on pre-existing compositions or culled from a library of musical snippets. From phase two, I learned that a live performance should propose a clear aesthetic direction. Considering the amount of time available, I decided to put an emphasis on daily practice and to create a new sketch every morning. I used an approach of free improvisation where the only constraint was to produce something new every morning in 20 minutes. I maintained this routine uninterrupted for over seven months.

I attempted to retain a focus on the daily process, giving more importance to the routine aspect than to the specifics of what I played and recorded. This approach afforded me the freedom to explore new techniques, as the commitment to each new idea did not extend beyond a daily session. As the weeks progressed, slow changes became apparent. One of the most significant changes was my exploration of syncopated beats rather than strict four to the floor patterns. Another recurring characteristic of the sketches was the preponderance of Vangelis type synthesiser sounds as typically heard in the *Blade Runner* soundtrack. Once I became aware of

this tendency, I acquired the Arturia CS-80 plugin, a software emulation of the Yamaha CS-80 used by Vangelis, and incorporated it as a recurring instrument. As a direct consequence of my work on the Plastikman Live set, I set out to find a personal approach to using the Roland x0x drum machine sounds. I borrowed Hawtin's Maschine and the included TR-808 soundset soon became an integral part of the sketch writing process. It has played a key role in virtually every sketch starting in mid-March 2012.

I deliberately kept a restricted palette of timbre, focused around synthesisers linked to early electronic music movements. In addition to the CS-80, which can be linked to the emergence of electronic instruments in rock and popular music in the 1970s, I also began regularly using sounds from the Hammond Novachord. The Novachord, manufactured between 1939 and 1942, is the earliest commercial polyphonic subtractive synthesiser. Its timbre is reminiscent of horror and science fiction movie soundtracks from the 1940s and 1950s. Several high-quality sampled sound banks of the Novachord are now commercially available. The Moog Voyager is another core element in my production setup. Despite its limitation as a monophonic synthesiser, the fact that it is a physical unit with knobs and a keyboard creates a sense of immediacy that cannot be found working with a mouse.

My daily work became focused on the structure of the setup and the physicality of improvisation. The timbres are retro, but the methods I use for controlling them are very modern. I sometimes program a custom Max for Live patch as part of the improvisation

process. That new patch then becomes part of the default Live Set which I would use the next morning. I configured the Maschine hardware controller to work in tandem with a Lemur template to give me full control over the Nepheton plugin. This setup provided a complete interface for a TR-808 emulation. I progressively built a Lemur template for the CS-80 plugin. As time went by, the overall setup gained complexity but I also became more and more comfortable improvising with it. Six months into the process, I would turn on my computer and the machines, press the record button and find out what happens. I became extremely familiar with the layout of the machines and the functionality of the custom controllers I had built. I experienced firsthand how software, through a custom controller setup, could act as an extension of my body. It felt like I had succeeded in creating my own cage, a term used by Hawtin to describe his own relationship to the machines.

Through the daily sketch process in phase three I created an abundance of material and I found a personal approach both in terms of aesthetics and technical production methods. Yet, in spite of these rewards, in early 2012 it was still not clear if this process was a means to an end, or an end in and of itself. The next phase was an attempt to discover where the sketches from phase three could lead.

2.4 Phase Four

During phase four I created fully fleshed out tracks based on previous sketches. This is a similar process to phase two, where I produced tracks based on material from phase

one. The difference was that now, based on the idea expressed in Attali's Composition period, I was not clearly attempting to produce tracks in a specific sub-genre. I was playing with the idea of making music for its own sake without conforming to a particular sub-genre of EDM.

Ascent (based on 111223 premise for promise)

Mathew Jonson's 'Learning to Fly', a track released by Minus in the summer of 2011, caught my attention because it is very melodic, in contrast to most Minus releases. Although I was familiar with Mathew Jonson's name, I was not yet familiar with his music. I discovered a body of music that was interesting because of the balance of a reductionist instrumentation and traditional melodic technique. One of his older hits, 'Marionette', particularly struck me. I analysed and deconstructed the main riff, it turned out to be a polyphonic melody as found in the arpeggio section of Bach's *Chaconne*. Having discovered the set of rules that govern the pattern in 'Marionette', I was able to create my own version based on a different harmonic sequence and different octave displacements. The result of this work is the sketch from December 23 2011, around which I produced the full track 'Ascent'. The track uses major chords with a flat sixth, a chord I particularly enjoy and that I do not often hear in minimal techno. In addition to the arpeggio inspired by 'Marionette', the track also uses strings in the background inspired by those in Plastikman's 'Ask Yourself'.

Heartstrings (based on a sketch from August 2011)

I sometimes create tracks as exercises in style, based on a particular artist or label's sound. This track is a pastiche in the style of James Holden's label Border Community. I attempted to create my variation of the style by using chords unusual for this style, borrowed chord, Ab Major, while the rest of the track is in C Major. An excerpt from this track was used as part of the soundtrack for the Lemur app launch video, which received over 100,000 views on YouTube as well as several comments requesting the track as a download.

Dreamscape (based on 111222 dreamscapes lost)

This track emerged as an outgrowth of my interest for Vangelis type synthesiser tones, as well as an interest in exploring new tempi and drum patterns. Having focused on minimal techno for many months, I wanted to try a slower tempo for the sake of variety.

Descent (based on 111220 hi-fi low high)

This track is based on a technical experiment that grew out of the polyphonic delays I had created for 'Ping Time'. I realised that the Max for Live patch I had built could also be used to simulate rubato in electronic music, where one voice gently lags more and more before picking up speed again to catch up with the rest of the music. The effect is particularly noticeable in the sketch at the points where the instrumentation is as bare as possible. I produced many different versions of the track, many of which obscured the rhythmic process. The final arrangement was chosen as a balance where the mix and instrumentation does not interfere with the clarity of the rhythmic process.

I made a bigger effort to push these tracks to labels than I did with the tracks from phase two. The response I received seems to indicate that these tracks deviate too much from pre-existing sub-genres. Riley Rheinhold of Traumschallplatten Records, a well known German label specialising in melodic techno, wrote: “Nice a bit 70ies... vintage feelingrrr. (*sic*) [...] too vintage for us [...] but good” (Email correspondence March 13 2012). I later understood that it makes little sense to send downtempo tracks, such as ‘Dreamscape’ and ‘Descent’, to an uptempo EDM label such as Traumschallplatten. The process of producing these tracks was satisfying, and the tracks themselves feel like strong personal statements. They do not, as a collection however, seem to exhibit a coherent aesthetic direction. The two downtempo tracks ‘Descent’ and ‘Dreamscape’ reflect a disinterest in composing within a definite EDM archetype. On the other hand, ‘Ascent’ and ‘Heartstrings’ might well comply with an EDM archetype, but not that of Reinhold’s Traumschallplatten label or Hawtin’s Minus label.

2.5 Phase Five

The daily sketch process in phase three produced hundreds of musical fragments. Inspired by the brevity in John Zorn’s *Naked City* project and Zomby’s *Dedication* album, I saw that, given the proper context, some of these sketches could stand on their own as compositions. I set out to compile an album of miniatures. I selected 24 sketches from phase three and polished each one by working on the mix and trimming the structure. In a few cases, I combined elements from two or more sketches to

produce a new miniature. Some of the miniatures are structured as a single musical gesture, whereas others present EMD structures of build-ups and breakdowns, albeit in a very succinct format. The average length of each miniature is less than a minute.

Miniature 1 (based on *120513 beautiful isms*) is a late track that uses a sparse drumbeat and a polyphonic melody. It was recorded in one take by setting up an arpeggiator and improvising widely spaced dyads on the Moog Voyager.

Miniature 2 (based on *120112 rather ill at the moment*) is the first of two sine tone interludes based on sparse textures. A high-pitched sine tone bell melody acts as a distant counterpoint to a deep muted sine tone bass. The registers in between are left nearly empty.

Miniature 3 (based on *120426 intentionally left blank*) reflects an expressionist approach. Rather than focusing on formal structures or instrumental technique, I tried to convey the mood I was feeling at the moment.

Miniature 4 (based on *120525 lancée*) contains three ideas: descending parallel diatonic chords in A minor, a hip-hop influenced TR-808 beat and an ascending glissando melody. The beat starts before the chords have completed a full cycle of repetition, and so obscure the larger cycle's downbeat. In a similar fashion, the glissando melody enters mid-phrase. These desynchronised entries are reminiscent of the technique used by Hawtin in 'Plasticine'.

Miniature 5 (based on 120425 mnmI) is structured as an ABCBA arch form and follows typical minimal techno motifs in a style similar to Marc Houle or Gaiser. Each section lasts only two bars and avoids the long repetitions usually found in a techno track. The track's structure eschews the repetition of techno, but retains typical timbres, patterns and section divisions.

Miniature 6 (based on 111212 time's an illusion) is the first of several miniatures which introduce an organic sound source, either sampled or recorded. I sampled a short snippet of a character's speech in Don Hertzfeldt's animated film *I Am So Proud Of You*: "The passing of time is just an illusion, because all of eternity is actually taking place at once" (Bitter Films 2008). I used the background music in the sample, edited to fit a 4/4 bar, as a *cantus firmus* upon which I improvised new melodies.

Miniature 7 (based on 120501 rubicon trail) is another late miniature that reflects my growing ease with complex drum patterns. It also marks a departure from my typical inclination towards melody and harmony.

Miniature 8 (based on 120424 six e-pianos) reflects the usage of digital communication technologies. This miniature uses a short sample of Steve Reich's *Six Pianos* as recorded by a Japanese artist I found while browsing randomly on SoundCloud. I contacted this musician and he willingly sent me the original WAV recording. I sampled and looped a single bar and recorded new parts on top.

Miniature 9 (based on *120209 willing experiment*) is an experiment in radical simplicity. As in Robert Hood's 'Minus', I reduced the drums to nothing more than a kick drum. The music consists of a single synthesiser that is modulated through timbre, harmonic changes in the sequence, accelerandi in the arpeggiator and manipulations of the effect feedback chains.

Miniature 10 (based on *111221 numbers i know* vocoded) uses my own voice as a source of organic sound material. I reference Kraftwerk's *Numbers* from their album *Computer World*. However, in my case, the significance of the enumeration is personal. I state the first numbers in the languages with which I am fluent or highly comfortable: English, French, German and Hebrew. The incorporation of Hebrew is also intended as a subtle link to Reich as he incorporated Hebrew cantillation and Jewish themes in his later works.

Miniature 11 (based on *120511 suspenders*) is the result of a fortuitous accident. I had recorded a short sketch playing descending chromatic harmonies, and, as I reviewed the recording, I inadvertently left iTunes playing Bach's Sonatas and Partitas for solo violin. The particular movement that was playing happened to be in the same key as my sketch. I sampled that segment and incorporated it into the miniature.

Miniature 12 (based on 120104 *not quite what i expected*) is the second sine tone miniature. This one acts as a quiet interlude mid-way through the album. The concept is identical to *Miniature 2*, but the harmony and melody are different.

Miniature 13 (based on 120121 *inspector void*) is one of the earliest sketches that explores the CS-80's palette of timbres.

Miniature 14 (based on 120206 *no title*) is a simple track that focuses on harmony and melody. I selected synthesiser timbres reminiscent of 1980s synth pop and improvised a short phrase. This track, despite its brevity, is divided into three sections. The sections exhibit a staircase structure where the drums enter first, followed by the bass, and finally the melody.

Miniature 15 (based on 120507 *sighlence*) is a late sketch that fully incorporates the TR-808 drums, Novachord sample bank, Moog Voyager and theremin-like solo melody.

Miniature 16 (based on 120608 *crimes*) is a throwback to *Miniature 9*. The solo arpeggio is simpler as it is modulated with only two parameters, harmony and timbre, whereas *Miniature 9* also played with the arpeggiator speed and octave displacements. The technique of modulating a single arpeggiated synth line in all three aspects, temporal, harmonic and timbral, carries prospects for future work.

Miniature 17 (based on *120505 plagialism*) is a disjointed, angular beat in two parts, divided by LFO synth noises. It is part of a series of a series of experiments with new types of drum patterns, rather than straight 4/4 techno beats.

Miniature 18 (based on *120410 chill out dr hombre*) is a calm interlude. I played with snare and hihat rolls in 32nd notes as in 'Spastik', albeit at a much slower tempo.

Miniature 19 (based *120414 war on drugs*) uses my own voice as an organic sound source. I pitched down the recording to create an effect similar to Plastikman's 'Ask Yourself' or Marc Houle's 'Techno Vocals' (2007).

Miniature 20 is a cross between two sketches: *120409 so sue me* and *20312 airport focus*. Each sounded thin on its own. I used the synthesiser noises of *so sue me* as background textures to the melodies of *airport focus*.

Miniature 21 (based on *120417 epic wail*) emphasises TR-808 beats while using the Novachord and CS-80 as background textures.

Miniature 22 (based on *120424 serendipity*) is one of the slower tracks on the album. It serves as a final interlude.

Miniature 23 is based on long improvisation with the Maschine, Voyager and Novachord. I reviewed the recording and used the best minute to produce this track.

Miniature 24 uses a recording of vinyl noise as an organic background sound. I combined the ascending fifth from *120226 slow* with the descending major chord progression from *120522 infinite choices* to create a calm sense of finality. This miniature closes the album.

The miniatures album expresses a willingness to create music primarily with the goal of obtaining joy. I deliberately allowed myself to follow stylistic whims and to propose an unusual format. The miniatures marked a conclusion where I fully explored the idea of Attali's Composition period. I understood that my musical work does not need to be restrained strictly to one approach, and that different tracks can serve different purposes.

2.6 Extras

I created three tracks that did not fit into any particular phase. All three of these were created initially for the sake of obtaining joy.

Needful Things

I produced this track in late August 2011, shortly after completing the tracks from phase two and before embarking on the daily ritual of phase three. I felt stifled by the melodic and timbral constraints I had imposed on myself in phase two. I explored

brighter timbres and synthesisers typically associated with late 1970s electronic music or progressive rock. The track was improvised in a series of one-take overdubs.

Pattern Seven

This track was produced in the same period as *Needful Things*. It was also improvised and recorded live on keyboards, thus placing an emphasis on using my body as I trained it through a traditional instrumental music education.

You Yeah You

This track was produced in early 2012, based on the *Helsingor* sketch from December 2011. This sketch suggested a pop feeling, which I attempted to fully explore as a way of challenging myself. I found an English-speaking singer in Berlin experienced with pop idioms and we collaborated on lyrics. *You Yeah You* is unique in this body of work due to its verse-chorus structure and its bridge with contrasting harmonies. This track garnered interest from a contact in the pop music world who suggested I created a three-track demo in this style with the goal of selling it to a publisher. This is an opportunity I plan on pursuing after my thesis is complete.

2.7 DJ Set

In June 2012, as an Off Sonar event, Minus opened a temporary space in Barcelona during the Sonar annual electronic music festival. The Minus Space hosted a cafe and store during the day, as well as a party location. Before the dance floor started in the

evening, I was asked to play a DJ set as a warm up set. I used the opportunity to play material recorded in the past year and judge the public's reaction. I prepared all the music from phases two, three, four and five in Ableton Live.

The reaction to the *Miniatures* album was interesting. Although people enjoyed the musicality of each track, the format seemed to consistently catch listeners off guard. The feedback, both direct and indirect, was generally quite positive. Comments were complimentary, and so were approving glances and body language. I understood that playing *Miniatures* in public requires a more focused, concert style setup where sudden silences would not interrupt conversations. Alternatively, I could rework the themes and materials from *Miniatures* into longer, more repetitive forms.

The reaction to the techno tracks from phase three, however, was very positive, as people started moving to the beat in the space. Seeing this, I had to review my previous assessment. These tracks, while they still do not feel like an overly original statement of the genre, seem perfectly adequate at performing their function of making people dance and confirming a minimal techno mood.

Although I did not have much time to prepare performance methods, the DJ set confirmed that I now have enough quality material on which to base a live set. Unlike phase one, where I did not have predefined compositions, I now have a clear repertoire of successful material. Building and performing a live set based on these tracks will be one of my next areas of focus. The DJ set also confirmed the necessity of playing EDM

in public, it is only through live performance that one can really assess how an audience will react. My own judgement of a track is not enough, I must use feedback from the public and my observations during a live set to decide if tracks are successful.

2.8 Score

The four phases unfolded from April 2011 to June 2012, in just over a year. Although the aesthetic and technical devices varied considerably, I realised that my approach exhibited one overriding constant. The routine of making music first thing in the morning every day, if only for 20 minutes, became a central element in my life. The act of daily practice became as rewarding in itself than the final products of fully produced tracks. I became very much aware of the physicality of the act as my body was interacting with sound through a custom setup of machines. The daily sketches acquired a level of significance somewhat difficult to describe in words, precisely because the significance of the activity was found through action rather than thought. The conscious pursuit of this daily activity, involving both the mind and body, has been transformative.

Composition 2012 #1 is my attempt to articulate the value of this improvisatory approach. The score contains but a single instruction: “Record something every day.” As the instruction is framed as a musical score, the act of recording sound is framed as a music performance. Thus, if Cage removed intentional sound in *4’33”* and Young removed the audience in *Composition 1960 #6*, I propose that *Composition 2012 #1*

replaces value judgement, communication, commerce and marketing with unwavering focus on the act of recording as the meaning of musical performance. This approach resolves the questions posed in the political economy chapter, concerning the relationship between EDM and money, by avoiding them entirely and placing the focus on practice and recording.

EDM is for its audience primarily an embodied experience. I have discovered through an analysis of Hawtin's approach and then through my own experiments, the importance of its production and performance also involving an embodied experience. My approach to production, involving a daily ritual of improvisation and recording, is a personal, individual, and private activity. This ritual showed me that music-making, as a daily practice, could provide meaning to life and be its own reward. The transformative effect, a result of focus and discipline of the mind and body, could be described as quasi-mystical. As a result of maintaining this focused approach during so many months, I began to feel connections between music-making and my physical and mental health. Much like Rietveld's idea of the cyborg, I became so attuned to the machines at the end of my fingers that they sometimes truly felt like an extension of my body. In spite of the decades of experience I already had with music, either through producing electronic music or playing acoustic instruments, I found that the cybernetic links had to be learned practically from zero. Every new setup for electronic music-making is a new instrument and a new cybernetic interface.

I could hear my state being reflected in the way I played and recorded. The act of recording at the same time every day, shortly before sunrise, made me acutely aware of the 24 hour cycle of the day. Making music became a reason for waking up. Practicing composition in this manner, an embodiment of Attali's Composition stage, led back to ritual. This first-hand experience suggests that Attali's four stages of music might be conceived as a cycle rather than a linear progression. The recordings resulting from this private ritual can be crafted into fully-fledged tracks, and either shared as free public documents, or sold as consumer products in the global electronic scene. In either case, the result is a communal experience and a further progression through the stages of Attali's cycle of music.

3. Conclusions

3.1 Summary

This thesis has revealed minimal techno, as it is practiced through Liine software, the Plastikman Live show, and through my own productions, to be a deeply improvisatory form of music. The relationship between body, mind and sound has emerged as one of the major themes. Minimal techno production and performance can be seen as a reflection of the profoundly changing relationship between man and digital technology.

Although much has already been written about EDMC and the specific history of techno, a large proportion of the existing literature stems from a sociological or cultural studies perspective. This study, however, was concerned with music theory and musicology, where the body of existing literature is more limited. One of the original contributions of this study is an in-depth technical analysis of EDM production and performance from a participant observer perspective, focusing on minimal techno. No previous research has specifically focused on this area in detail. From my position as a music producer, technologist and director of a company that counts Richie Hawtin as a partner, I was able to gain access to a unique perspective and data set. Hawtin provided me with complete access to the Plastikman Live materials, including the authorisation to distribute a partial recording of one of the live performances. This professional association gave me access behind the scenes at major EDM events such as Timewarp and Sonar, and this privileged access has been a significant factor in making this study possible. Such access is important for studies that want to go

beyond an external study of audience reception, and delve inside the internal workings of a musical system such as this.

Minimal techno is a sub-genre of EDM that started in the early 1990s. A brief history has traced the evolution of minimal music in the West from Erik Satie in the 1890s to Plastikman in the 1990s. These musical forms have all been shown to share common musical traits, including audible repetition, a static and floating sense of time, a reduction in the quantity of musical materials, a sparseness of form, and a general aura of simplicity. In addition the influence of Non-Western musics, such as West African Drumming, North Indian Classical music or Javanese Gamelan, was confirmed as a frequent characteristic of minimal music. Minimalism, including minimal techno, emerged as an early artefact of or precursor to the global village (McLuhan 1961), prescient of the way cultural forms are now, through technology, transformed, exchanged and shared across boundaries of nationality as well as both high/low and east/western cultures.

Techno was first created in the mid-1980s with analogue music technology equipment such as Roland x0x drum machines and various other analogue synthesisers. A digital revolution in the mid-1990s created a situation where costly and unwieldy analogue recording studios could be replaced by software. A second digital revolution occurred in the mid-2000s where control interfaces could be run on reconfigurable multi-touch screens. The flexibility and low cost associated with software has had a major impact on both the production and performance of sound. These issues are central to the

production and performance of minimal techno and Plastikman Live. Without software such as Ableton Live, or multi-touch controllers such as Lemur or iPad, it would have been impossible to create a realtime interface permitting Hawtin to access every single musical aspect of his Live set.

Liine created custom software to enable a single performer, Richie Hawtin, to control a complex studio setup reproduced in a software environment. A detailed account of the reasons motivating design choices revealed that a control interface may be most effective when it reflects the structure of the performance and increases the efficiency of the performer's body. One such example is Grid, where design choices were customised to reflect the immense size of the Plastikman Live set, or Kapture, whose functionality directly solves challenges posed by the same Live set. Hawtin was now able to have control over every single parameter of every track in the Live set, effectively giving him the opportunity to improvise a structure with pre-composed materials. The gestures of Hawtin's hands are extended using software into the machines, in an instinctive fashion that enables invisible networks of notes and beats to feel as though they are emerging directly from Hawtin's fingers. His abilities as a human being are extended by virtually attaching drum machines and synthesisers to the ends of his arms.

A detailed analysis of the Ableton Live set used for the 2010-2011 Plastikman Live tour has provided an insight into Hawtin's working practices. It was unusual for its size, spanning nearly 150 tracks and 300 scenes. It contained the data for 14 songs and

permitted seamless transitions as well as improvisatory mixing and matching of different elements between songs. The methods used for organising the songs, explained in detail, include splitting up drum channels into component sounds, using a limited number of tracks for performance, using scenes to skip between song sections and using Kapture to recall initial settings for each song.

The analysis of one song as a case study, 'Plasticine', has illustrated further details. Although transcription in traditional notation has been useful, other representations such as the drum routing and return effects diagrams were necessary to convey the complexity and reconfigurability of such a setup. This analysis of Plastikman Live has revealed the highly improvisatory nature of Hawtin's performances. An in-depth interview with Hawtin, included in full in appendix I, confirms this conclusion.

The analysis of Plastikman Live, along with the previous analysis of Liine software and the interview with Hawtin, has confirmed the view that techno is a deeply technological music. Whether the participant is a dancer on the dance floor, a producer in the studio or a performer on stage, techno reflects the ever-growing ties between man and technology. This relationship is illustrated by Rietveld's cyborg theory, in which a crowd of dancers is in communion through a technological interface and under a DJ's guidance.

Attali's *Noise: The Political Economy of Music* (2001) provided a useful structure to examine the links between EDM, technology, and money. It's been possible through a

brief summary of Attali's first stages, Sacrifice and Representation, to show how his theories relate to EDM. His third stage, Repetition, provides a useful frame for the emergence of techno, and its relationships to recording and mass-production. Recordings serve as the basis for house and techno, where the DJ recombines existing records to create a new text. Repetition and the Internet are powerful agents in the creation of Hyper-Repetition. Hyper-Repetition is Repetition unfettered by the many restrictions associated with creating, distributing, storing and selling physical recordings. The political economy of techno has been defined in this context primarily through the mechanics of Hyper-Repetition, tangibly represented by online MP3 stores such as Beatport and file-sharing platforms such as MegaUpload. Global techno production can be seen as an exaggerated reflection of the structures of mass-production and mass-consumption.

Techno production on an individual scale carries potentially different meanings. It can be seen as an expression of the DJ taking pleasure in controlling machines and subsequently mediating dancers' relationship to technology. Techno production can also be understood as a form of acknowledgement between musicians, a means to confirm a common aesthetic ground and strengthen a sense of belonging. Attali's Composition period can be used as part of a framework guiding composition work. He proposes that the main goal of making music is to obtain joy. Such a perspective has to be balanced with the commercial structures presented by Beatport and the label system, as well as the social structures existing between a performer and the live

audience. Making music for the sole purpose of obtaining joy, as Attali suggests, does not address the musician's need to earn a living.

The analysis of Attali's Composition stage has led to several open questions. In the future, will professional musicians still fill the same roles, as they exist today? If not, how will musicians earn a living? And how will the answers to both these questions be reflected in the rest of society? In the field of EDM, musicians generally earn a living mainly through DJ gigs and live performances, not through the sale of recordings, a trend which appears to correlate with the adoption of digital technologies. It seems unlikely that the role of professional musician, as it exists in EDMC, will diminish in importance in the foreseeable future. For musicians working in sub-genres not associated with lucrative dance events, recent technological developments such as SoundCloud and Bandcamp offer promise for self-organised promotional and commercial infrastructures, where the artist can sell directly to a niche fan base and retain the majority of the profits from the sale of his recordings, therefore side-stepping the structures of Hyper-Repetition and using the Internet to enact a sustainable mode of Composition. Musicians can potentially make music not only for obtaining joy, but also to connect with a decentralised global audience and, through direct sales, earn a living. This usage of digital technologies by individual musicians might herald a new type of economy, where individuals in society at large, with niche skills and niche products, earn a living by dealing with a disconnected, global audience of paying customers. Such developments also suggest a growing de-professionalisation of music, with an increasing body of musicians making music for pleasure, and seeking to

make a living from other sources, whether music-related or not. Further research would be required to quantify the balance of these dynamics.

One of the reasons for making minimal techno is because it is a style of music particularly focused on the use of technology as an interface for connecting with the audience. Attali suggests that music is prophetic of larger changes in society. Just as Donna Summer's 'I Feel Love' was once at the cutting edge of the use of technology, so is minimal techno today. My research concludes that techno was futuristic and prophetic not because it incorporated themes of outer space and extra-terrestrials, but because it suggested future modes of communication between people. Techno was once a style of music that necessitated hardware, now it can be produced with inexpensive software. Controllers were once expensive, now they exist as inexpensive iPad apps. The aesthetics of minimal techno, as well as the use of cutting edge technology such as Grid and Kapture, point to larger changes in the way people use technology in popular culture, such as Facebook and mobile computing.

I produced original music as practice-based research, resulting in over six hours of recordings. These recordings were analysed in eight different stages, five main phases of work, a group of extra tracks, a DJ set using all previous material, and finally a score summarising my philosophical approach to composition and production. The five main phases illustrate the evolution of my compositional methods.

During the first phase I created a Live Set from scratch, with new musical materials and a structure inspired by the Plastikman Live set. It became clear that compositional materials have to be created first before using software tools such as Grid to perform them. EDM composition needs to operate in two stages, with each stage requiring a different skill set. The first stage involves the generation of content, whereas the second stage involves the manipulation and performance of that content. I was to find that multiple iterations of these stages of creation were required to develop music to the point where it was ready for publication.

During the second phase of composition I selected materials from the first phase and produced full tracks exhibiting typical techno structures. These tracks were later successfully played in public and received positive feedback from DJs to whom I gave them. Positive feedback can motivate a producer to create similar material, however, this type of relationship also presents a drawback. Composing in this context can feel like working for a client, rather than making music primarily for the goal of obtaining joy.

The third phase consisted of an on-going piece, an open score where the only instruction consists of 'record something every day'. I performed this piece for seven months, from December 3 2011 to July 3 2012. A significant conclusion of this project was defined in the score *Composition 2012 #1*, a title that references La Monte Young's series of conceptual pieces from the 1960s. This piece represents a fulfilment of Attali's Composition period, and it has shifted the emphasis of music-making from the end product to the process of daily practice, from Repetition to Hyper-Repetition and

Composition. My mindset changed in that I obtained joy and satisfaction from the discipline, but also from seeing the aesthetic evolution in the ever-growing chain of daily recordings. The process showed how a composition can represent a snapshot plucked from a living stream, rather than a fixed goalpost.

During the fourth phase I selected recordings from the third phase and produced full-length tracks that could be described as melodic techno or electronica. This began a period of exploration where I experimented with aesthetic devices outside of minimal techno archetypes. Moving from what Attali would call Repetition to Composition allowed me to cease trying to emulate the minimal techno style released by Minus, and allowed me to focus more on an original voice. It became easier to find a state of flow, as I was not producing for an imaginary audience of labels and DJs.

The fifth phase consisted of an album of miniatures. I selected 24 sketches from the third phase, corresponding to each week of the first six months, which I then polished and compiled into an album. This album will be the object of a public release that I intend to organise after the conclusion of this research project. I intend to pursue further work on my music by creating a live set based on the music from the *Miniatures* album. Playing the album during my DJ set at Sonar provided valuable feedback from the audience. Engaging with the public allowed me to determine which miniatures worked best, and in which order they might best fit. Compiling the album, a collection of single recordings from a much longer process, has created a link with the notion of eternal music found in classical minimalism.

The practice based element of the project has helped to illustrate the complex dynamics involved in the creation of techno music. It helped to understand the music from the inside, to show the importance of multiple cycles of creation, refining and performance that are necessary to develop the skills required to make such music, and the detail required for publishable musical outputs. It has illustrated the importance to techno composers of performing to an audience, and the difficulties of the balance between composition, production, improvisation and performance. Most significantly it has enabled an understanding of the complex relationships between joy and commerce, the private and professional. It has allowed an insight into the creative dynamics of Hyper-Repetition, and explored some of the issues a creator of such music must negotiate.

3.2 Future work

This project has identified the need for a range of further research that is needed to fully explore the questions and issues raised. The music analysis portion of this thesis focused on Plastikman. There are many other minimal techno artists whose work from the early 1990s merits attention, such as Robert Hood, Daniel Bell or Jeff Mills. A comparative analysis between different artists of the same period could yield a deeper understanding of the minimal techno sub-genre.

The aesthetics of minimal techno evolved between the 1990s and the 2000s. At the same time, the sub-genre grew in popularity. It would be interesting to trace its evolution both from a musicological and sociological perspective.

From a cultural studies standpoint, it would be interesting to look at the relationship between a superstar such as Richie Hawtin and the underground scene from where minimal techno originally grew, to ask how an artist of his status can maintain credibility once he's acquired worldwide fame.

Liine developed bespoke technology for Plastikman Live. In the past year, other artists have begun using Grid to control their live set. In 2012, Orbital hired Liine to help them prepare their live tour. A study could be conducted on the way interactive technology has been adopted within EDM, and how it makes its way from bespoke solutions to common usage.

3.3 Synthesis

Our society is fascinated with technology, the idea of progress, and digital communication. We take great pleasure in communicating with each other, something that can be seen by the growth of digital social media networks, a fact confirmed by Facebook's CEO Mark Zuckerberg's recent announcement that the site has reached one billion users (Zuckerberg 2012). We obtain joy not only by interacting with fellow humans through technology, but also through playing with technology itself.

We still value physical congregation, as demonstrated by the fact that commercial exchange in EDMC is largely centred on techno events. However, as well as the experience of attending an event, and communicating through dancing, other

technological mediations are present, such as the act of documenting that experience with a mobile phone video camera, or by the act of interacting with the artist on stage through an app such as SYNK. We carry mobile devices that enable us to record and share our lives through text, audio and video. Our lives are becoming intertwined with digital technology, a process accelerated by the digital revolution and the mainstream adoption of mobile devices such as smart phones and tablet computers.

In the field of EDM, the intertwinement of man and machine is accelerated by the shift to software in production and performance. Our attention has moved from physical hardware to virtual software. Music software itself is immaterial and invisible. It exists only through the pixels it animates and the sound waves it creates. There is no separate object other than the multi-touch screen, itself reconfigurable through software. The move from hardware to software contributes to blurring the distinctions between organic and synthetic. Negotiating a cyborgian relationship with technology through software, rather than through hardware, is a quantifiable step in the process by which computers, once gigantic devices filling an entire room, become invisible extensions of our bodies and minds. The seamless and transparent merging between man and machine may one day extend to cybernetic implants. The technological interface is invisible to the audience, and in time might become invisible to the artist.

As the presence of digital technology becomes increasingly ubiquitous in our lives, there will perhaps be less need for a musical style focused on our relationship with technology. At present, however, minimal techno remains a musical herald of a large-

scale transition in society. As Kurzweil (2002) declared, "we are becoming cyborgs". Minimal techno embodies this transformation, and Hawtin, as Plastikman, embodies minimal techno. This case study has shown us an example of this transformation through the artistic practice of one individual.

Such interactions between man and machines are usually a secular act, machines playing utilitarian roles in our daily lives. Musical structures such as those found in minimal techno allow us to explore deeper, more significant relationships with technology, to let machines further into our psyche, and to reduce fear and mistrust associated with the inorganic. Hyper-Repetition and Composition combine to complete a circular path from the commercial world of Repetition, to the personal space of Ritual, and are encouraging us to integrate technology into our internal lives, and explore newly expanded cyborgian methods and levels of communication. Such activities are prophetic not just because they are pathfinders rehearsing for similar activities in wider fields of human endeavour, but because they enable further developments such as removing fear of and opposition to machines' deeper penetration into human culture. This process goes on unconsciously amongst most participants, yet it is a significant point when we consider the degree to which we are embracing new technology in our daily lives.

My own experience of such cybernetic relationships, through both theoretical analysis and composition as practice-based research, has been a clear reminder of the body's importance. Minimal techno is a dance between artist and machine, as much as a

dance between artist and audience, and audience and machines. The way we interact with each other, through machines, is directly related to the way we interact with machines themselves.

Appendix I: Interview with Richie Hawtin

Audio recording is included as an MP3 file.

Full transcription is included as a PDF file.

Appendix II: Plastikman Live graphs and tables

Macro Structure

- Graphs/SessionView/SessionView.PNG: A very high resolution (~130 megapixels) screenshot of all the scenes across the first 36 tracks.
- Graphs/SessionView/SessionView.XLS: A spreadsheet of all the scenes across the first 36 tracks.
- Graphs/DrumRouting/00_DrumRoutingAll.PDF: A diagram depicting the breakdown of all the drum synthesisers and accompanying audio routing. This diagram shows all possible drum sounds for the performance, whereas each song only uses a selection of about a dozen drum sounds.
- Graphs/ReturnTracks/ReturnTracksAll.PDF: A spreadsheet containing the feedback settings for all Return Tracks (the equivalent of effect sends/returns on traditional mixers). These are mixer settings recalled by Kapture Pad at the beginning of each song.

Song Structures

- Graphs/DrumRouting/XX_SongName.PDF: A diagram depicting the specific combination of drums for each song.
- Graphs/ReturnTracks/Return Tracks Sends Matrix X.PDF: A diagram for each configuration of the Return Track Sends.

Appendix III: Plasticine score and recording

Stereo recording is included as an AIF file.

Score is included as a PDF file.

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