Unpredictable Popular Music:

History, Praxis, Perception: Cryptography, Serialism, Pseudorandom Generation, Chance, Improvisation and Infinite Monkeys

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ABSTRACT

The work presented in this thesis concerns unpredictability in popular music and provides an investigation into how unpredictability may be received and perceived. Most popular music is marked by an emphasis on predictability, with the aim of fulfilling the listener's expectations. Pop songs are designed to be instantly memorable – a quality drawing upon simple melodies, much repetition and structural familiarity. Pieces of popular music that utilise unpredictability may be regarded as taking up a critical position towards the popular music industry's dependence on, and reluctance to look beyond, songs that are familiar in both form and content.

During the 1960s and 1970s, a number of rock groups, inspired by the avant-garde, set out to prove that commercial forms of music could be vehicles for progressive and experimental ideas. These groups, in particular Frank Zappa's, were successful at incorporating unpredictability into popular music. Zappa's approach to composition exposed the formulaic characteristics of popular music, with the intention of discovering new and unconventional musical forms. His cryptic treatment of thematic materials draws comparisons to cryptography in the sense that meaning is often hidden. This thesis expands on this idea through an investigation of encryption algorithms and their musical application.

Set within a broad historical context, covering aspects of the avant-garde as well as popular music, different methods of achieving unpredictability are investigated, such as serialism, randomisation and improvisation. It has been found that there exists a dialectical relationship between order and randomness, to the extent that, under certain conditions, order may be perceived as randomness (described as "quasirandomness") and randomness may be perceived as order (described as "quasiorder"). An investigation of how these two conditions may be used musically contributes an important line of enquiry throughout this thesis, with compositions and etudes serving to demonstrate the application of the new techniques developed.

CONTENTS

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I am dedicating this thesis to my parents, as thanks for all their support over the years.

CHAPTER 1

INTRODUCTION

Unpredictability is not usually associated with popular music but over the years some of the more adventurous musicians working within pop and rock have explored its potential, at times with a reasonable degree of commercial success (e.g., Fantômas, Frank Zappa, Sonic Youth and The Grateful Dead). This thesis aims to show that new ways of incorporating unpredictability into popular music are possible and that in spite of the music industry's relentless output of predictable products, a little of the unexpected can still contribute to the progression of the art form.

All music exists somewhere along the predictable/unpredictable scale but because of the wide variety of different techniques composers use, pinning down the exact position of one piece in relation to another is no easy task. The degree of predictability of a piece of music is a measure of the listener's ability to assess what they have heard in order to accurately state what they are about to hear. As such, it is closely associated with the perception of musical events, both vertical (of the moment) and horizontal (over time), whereby, the harder it is to foresee an outcome, the more unpredictable the music may be perceived.

Most popular music meets with the expectations of its listeners by conforming to certain acceptable and familiar patterns of behaviour. This can be exemplified by imagining listening to a piece of commercial rock music. As each moment passes it becomes increasingly clear that the music fulfils certain expectations concerning beat placement, chord progression, tempo, structure, timbre and dynamic, the characteristics that make it rock as opposed to (for example) techno. As the first four bars conclude, one can predict that the next four bars will be similar. It is likely that a chorus or pre-chorus will follow each of the verses, and that there will be a contrasting section of music towards the end.

Predictability/unpredictability is perceived at the level of the details and structure but it is also informed by the listener's ability to identify the genre as rock. In gathering together musics which have things in common, based as they are on the patterns that music consumers and record company marketing departments use to match like with like, genres raise issues concerning predictability.

This thesis approaches its subject by way of three different methodologies: historical (Chapters 2 and 3), praxis (Chapters 4 and 5) and issues pertaining to perception/reception (Chapter 6). A broad historical survey investigates unpredictability in both art and popular forms of music, and provides the foundations for the development of new and innovative compositional approaches. Also investigated are the relationships between perception (how we interpret what we hear), reception (how we react having interpreted it) and the commerciality of unpredictable pop music (how the music industry responds to audience reactions). The methodologies of each chapter are summarised below:

Chapter 2 – "Relevant Histories" – discusses the development of unpredictability in both avant-garde and popular music. It traces the history of chance-based composition processes as well as systems approaches, such as serialism, which relates to the investigations into formalised methods of generating "quasirandomness" (a generic term for order perceived as randomness) in Chapter 4. Chapter 3 – "Unpredictability in the Music of Frank Zappa (1940-93)" – provides a close examination of the compositional and improvisational techniques used by Zappa to generate unpredictability. His explorative uses of randomness are also investigated. Zappa's music often exhibits cryptic qualities which may be perceived as random but are actually part of a complex order. The idea of cryptic music is taken a step beyond Zappa in Chapter 4 – "PRN Generation and the Application of Encryption" – which begins with an introduction to the subject of cryptography. A comparison is made between a method of encryption called the Vigenère Cipher and the serial procedures of Pierre Boulez in *Structures 1a* (1951), arguing that both behave like PRN (pseudorandom number) generators, producing random-like patterns through formalised procedures. These discoveries inform several new compositional procedures based on PRN generation and cryptography, in which ordering processes designed to produce quasirandomness are explored. This principle is dialectically linked with that of Chapter 5 – "Quasiorder: Repetition and Randomness" – which investigates "quasiorder" (randomness perceived as order) through an understanding of the factors that contribute towards predictability in popular music, in particular, repetition and structure. Drawing upon the theoretical writings of Theodor Adorno and Richard Middleton, the close relationship between these two characteristics of music is investigated. Quasiorder is achieved by randomising one of the most familiar types of repetition found within popular music: the riff. The compositional strategies of the KLF and John Oswald are discussed, enforcing the idea that repetition and predictability are strongly connected to structural familiarity. Chapter 6 - "Reception and Perception" – discusses the reality of performing unpredictable popular music in bars and clubs, and attempts to develop a better understanding of how randomness in music is perceived. Chapter 7 contains a summary and the conclusions of the research.

In addition to the main chapters, there exist a number of appendices referred to throughout this thesis. Of particular interest is Appendix A, which comprises the musical analysis of a number of pieces composed alongside this research. Appendix B contains the binary grids referred to in the experimental composition processes explained in Chapter 4; Appendix C provides musical scores; Appendix D consists of interviews and surveys; and Appendix E contains miscellaneous supplementary material. Also indicated throughout are references to the recordings contained on the accompanying CDs. It should be noted that abridged examples of pieces are used in cases where they are non-teleological.

1.1 EXPERIMENTAL POPULAR MUSIC

There is no definitive definition of experimental popular music. What actually exists is a plurality of ideas and approaches to music making that push beyond popular music's traditional values; it operates within the sphere of popular music, whilst refuting the conventions and expectations that this might otherwise imply. The compositions and etudes created alongside this research may be described as examples of experimental popular music because, for the most part, the techniques they prescribe differ from those used in music aimed towards chart success, owing as much to avant-gardism as they do rock 'n' roll. This diversity is reflected in the historical context of the research set out in the second chapter.

In attempting to contextualise experimental popular music further, the following definitions of experimental music provide a good starting point:

1. Synonymous with avant-gardism (Paul Griffiths, Robert Fink and Herbert Eimert)
2. Music made in a laboratory (Lejaren Hiller, Pierre Schaeffer)
3. The performance of music of which the outcome cannot be foreseen (John Cage, Michael Nyman, Wim Mertens and Joaquim M. Benitez)
4. Music in which the innovative component (not in the sense of newness found in any artistic work, but instead substantial innovation as clearly intended by a composer and/or performer) of any given aspect of a given piece or performance takes priority above the more general technical craftsmanship expected of any art work.[1]

Experimental music is, therefore, not so much a genre as a term that can be applied to music of any genre that may or may not set out to prove a theory. So that, whilst experimental musics may differ considerably, a key objective is often shared: that of discovery. This is as true within popular music as it is within art music. The approach adopted in this thesis does not add to the above definitions but reflects them all to some degree. For example, it draws upon the avant-garde (e.g., formalised approaches) but not exclusively because it also draws from popular music; some of the techniques developed necessitate computer realisation, whilst others require the input of musicians; compositions are created that may be perceived as both predictable and unpredictable to some extent. The final definition is relevant in the sense that the innovative components of the research are the new composition techniques developed out of a better understanding of unpredictability.

[1] Landy, Leigh, *What's the Matter with Today's Experimental Music?*, Chur, Harwood Academic Publishers, 1991, pp. 3-7. It should be noted that the fourth of these definitions is Landy's own.

The challenge of locating relevant source material was exacerbated by the very specific area of the research. The fact is, very little has been documented about the techniques used to achieve unpredictability in popular music. Sources tend to be thinly scattered across the many histories of popular music. Occasionally, one-off accounts appear in band biographies and interviews, such as the story of Lowell George of the progressive country rock group Little Feat, who wrote some songs by throwing darts at a wall-chart of guitar chords,[2] but no single body of work has tackled the subject in any depth. One option is to turn to other areas in music where unpredictability has played a role, e.g., the avant-garde.

This raises a more general point about whether it is enough for popular music studies to operate without passing reference to musics that fall outside the "popular" categories. Part of the problem comes about because of the different value systems of each. Whereas the intelligentsia might celebrate Cage and Boulez as two of the 20th century's greatest musical pioneers, admired as much for their minds as their music, popular music's great experimentalists sometimes seem to receive little more than passing references, having failed to embody the one quality popular music deems essential: mass accessibility. Having said that, experimental popular music continues to be made and generate interest. Today, the genre-defying group Fantômas explore eclecticism in a manner akin to Zappa and John Zorn, Sonic Youth have released versions of pieces by Cage, and The Acid Mothers Temple perform extended freeform "noise rock" improvisations.

1.2 TERMINOLOGY

The terminology used throughout this thesis is wide-ranging, covering techniques associated with both popular and avant-garde music. The definitions provided in this section aim to clarify some of these terms, namely those associated with unpredictability:

[2] Courrier, Kevin, *Dangerous Kitchen: The Subversive World of Zappa*, EWC Press, Toronto, 2002, p. 104.

improvisation, indeterminacy, aleatory, open form, chance, stochastic and randomness. Particular attention is spent on the last of these which plays a key role in later discussions. Improvisation – Music that requires improvisation is intended to sound different at each performance; however, it would be wrong to assume that improvisation must therefore be highly unpredictable. For example, jazz and rock improvisation can become rather formulaic if certain scales and harmonic patterns are favoured, to such an extent that it is possible for computers running automated improvisation algorithms to jam with real musicians.[3]

At the other end of the scale there is free improvisation. This may be perceived to be considerably more unpredictable than a jazz improvisation since it is performed without a pre-set target and with no structural limitations in place. In the case of group free improvisation, however, predictable patterns of tension and release may exist as improvisors navigate their individual paths. Unlike Cage's scores which aimed to remove personalities from musical creation through non-intention (see Chapter 2), free improvisation is full of the personalities of those involved.

Indeterminacy – This relates to those aspects of a performance which are left undefined by the composer (e.g., pitches with non-specific durations, durations with non-specific pitches) most likely resulting in an unpredictable listening experience. Often an indeterminate piece will involve improvising to some extent, so that although there may be non-intention on behalf of the composer, deliberate choices are made by the performer(s). The degree to which an indeterminate score may be perceived unpredictable largely depends on which musical parameters are left undefined.

Aleatory – This word comes from the Latin for dice, *alea*. It simply implies that a process of random selection (e.g., rolling dice, drawing playing cards from a pack) is used to make decisions usually made by the composer. To this extent, an aleatory process will introduce

[3] For example, Al Biles's genetic jazz improvisation algorithm called *GenJam*. http://www.it.rit.edu/%7Ejab/GenJam.html

unpredictability into a work. Also counted as aleatory are those pieces where the order of execution of each section is made by the performer. As a composition technique, it is closely associated with twentieth century explorations into musical automation.

Open Form – A work may be described as being in open form if individual sections or elements can be arranged differently for each performance (freely or according to some influential factor) and as such can be described as indeterminate. Open form techniques can be used to create varying degrees of unpredictability.

Chance – One of the most obvious characteristics of chance is uncertainty. Marcus Cicero described it in *De divinatione* (1920): "For we do not apply the words 'chance', 'luck', 'accident', or 'casualty' except to an event which has so occurred or happened that it either might not have occurred at all, or might have occurred in any other way. For, if a thing that is going to happen, may happen in one way or another, indifferent, chance is predominant; but things that happen by chance cannot be certain".[4] Aleatory and indeterminate approaches are often referred to as chance procedures (Cage preferred "chance operations") because of the uncertainty they introduce into music making.

Probability – This relates to the likelihood of a chance event happening. Probability theory attempts a formalised approach whereby the probability of an event is defined as the number of equiprobable favourable outcomes divided by the total number of equiprobable outcomes. An equiprobable situation is one where each of the possible outcomes has the same probability of occurrence, e.g., when performing an aleatory process such as rolling an unbiased six-sided die, each side has a probability of occurrence of 1/6.

Stochastic - The word "stochastic" is Greek in origin and means "point of aim" or "target".[5] In mathematics, a stochastic process is a process of change governed by probabilities.

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[4] Bennett, Deborah, *Randomness*, Harvard University Press, London, 1998, p.153.
[5] Kennedy, Michael, (ed) *Oxford Concise Dictionary of Music*, 4th edition, Oxford University Press, Oxford, 1996.

Stochastic music is:

> [...] based on a process in which the probabilities of proceeding from one state, or set of states, is defined. The temporal evolution of the process is therefore governed by a kind of weighted randomness, which can be chosen to give anything from an entirely determined outcome, to an entirely unpredictable one.[6]

Randomness – Philosophers have tried on many occasions to define randomness, debating, for example, whether a random outcome needs to stem from a random process in order for it to be random; however, in taking unpredictability as a desirable feature, two contrasting interpretations stand out: either that randomness is a function of our inability to predict a result, or, that randomness is result of our inability to see a pattern which actually exists. Richard von Mises first proposed the former of these theories in the 1920s, defining the "randomness in a sequence of observations in terms of the inability to devise a system to predict *where* in a sequence a particular observation will occur without prior knowledge of the sequence".[7] This definition is closely related to gambling, whereby a gambler may follow a superstitious rule for when and how to bet, even though "there exists no system of prediction that could enable the gambler to bet in such a way as to change his long-run relative frequency of success".[8] In other words, the unpredictability of a random sequence prevents successful gambling.

The main criticism levelled at von Mises's theory centres on his conclusion that randomness cannot be described by *any* rule. A more popularly held belief today is that randomness results from our inability to make sense of highly complex systems. In the 1960s, the information theorist Andrei Kolmogorov argued that a random sequence is one with maximal complexity, whereby it cannot be described by simple rules. Kolmogorov's theory implies that the more complex something becomes, the closer to a state of randomness it becomes. This not only opens up the possibility of randomness resulting from non-random situations, it also introduces the possibility of there being degrees of

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[6] Wishart, Trevor, *Audible Design,* Orpheus the Pantomime, York, 1994, cited at the *ElectroAcoustic Resource Site (EARS)* http://www.mti.dmu.ac.uk/EARS/Data/node57.html
[7] Bennett, Deborah, *Randomness*, Harvard University Press, London, 1998, p.161.
[8] Ibid., p.161

randomness (i.e., minor complexity/maximal complexity). G. Spencer Brown approaches the degree of randomness from a slightly different perspective. Whilst he is quite happy for randomness to be generated by a non-random process (providing it appears random), he argues that randomly generated sequences which appear non-random (e.g., long runs of heads or tails, or alternating patterns of heads and tails) should be removed from random samples on the premise they do not appear disorderly enough:

> Our concept of randomness is merely an attempt to characterize and distinguish the sort of series which bamboozles the most people [...] It is thus irrelevant whether a series has been made up by a penny, a calculating machine, a Geiger counter or a practical joker. What matters is its effect on those who see it, not how it was produced.[9]

If the outcome rather than the process determines randomness, then a form of music like free improvisation might be described as random even thought it is created out of deliberate actions. In this thesis, however, random-looking patterns with non-random sources are referred to as "quasirandom".

1.3 GRAPHICAL REPRESENTATIONS OF UNPREDICTABILITY IN MUSIC: PROCESS AND PERCEPTION

The definitions of randomness provided in the previous section are particularly pertinent because in spite of their differences they are united in the belief that a desirable feature of randomness is the unpredictability of future events based upon past events. Throughout this thesis, graphical representations are used to show how degrees of unpredictability in music are perceived in relation to the composition processes involved. This section explains how this is achieved; paying close attention to the perception of randomness in music - a subject that becomes increasingly relevant in later chapters.

[9] Ibid., p.168, citing Spencer Brown, G. *Randomness I.* The Aristotelian Society Symposium Proceeding, Supplementary 31, Harrison and Sons, London, 1957, pp. 145-150.

1.3.1 Visualising Unpredictable Music

Cage's definition of experimental music, as stated in section 1.1, is specifically aimed at the perception of unpredictability during the performance of music. It describes a type of music where unpredictable events are fundamental to the listening experience, something that can be achieved in live performance through indeterminate processes. In the case of aleatory music, unpredictability stems from the randomisation processes used to make selections.

The predictability/unpredictability of a piece of music can be represented as a three-dimensional configuration (see *figure 1-1*) where the *x*-axis represents a quantity of some "unpredictable factor" (either improvised or aleatory), the *y*-axis represents a "control factor" (the composer's input/programmer's algorithm) and the *z*-axis represents the "degree of predictability/unpredictability" experienced by the listener. Although hypothetical, this graphical representation makes it possible to compare the unpredictability of different musical systems in terms of the processes they involve and how they are perceived. Variations of *figure 1-1* are used throughout this thesis, but for the sake of clarity, as three sets of two-dimensional axes: (*x*, *y*), (*z*, *y*) and (*x*, *z*).

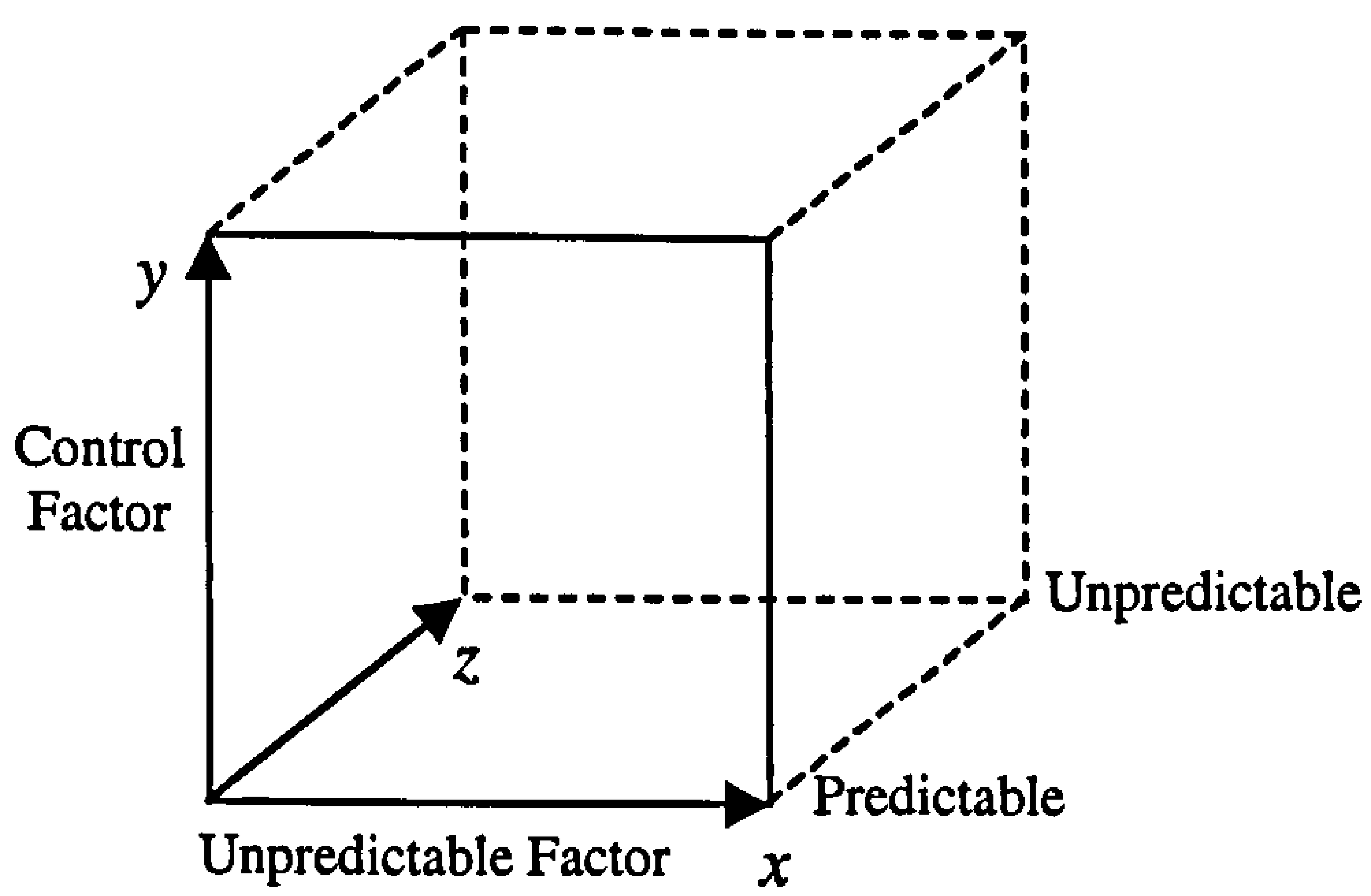

Figure 1-1: Graphical representation of the perceived unpredictability of a musical system

1.3.2 Visualising Random Processes in Music

Statisticians working in accordance with Kolmogorov's theory of randomness are able to ascertain the degree of unpredictability of a random-looking sequence through batches of tests designed to differentiate between truly random sources and complexity (which may in the long run contain patterns). When a pattern looks random it can be said to be "quasirandom", implying a kind of artificial or imitation randomness. A similar term is "pseudorandom"; however, this tends to be used in the context of formalised processes initialised with a random seed, in accordance with the definition supplied by Carl Ellison:

> A pseudorandom number generator (PRNG) is a function which takes a certain amount of true randomness (called the *seed* of the PRNG) and generates a stream of bits which can be used as if they were true[ly]-random [...][10]

In this thesis, quasirandomness is used in a more general way to describe any pattern perceived to be random upon visual or aural inspection which is the result of an ordering process. The perception of randomness is therefore divisible into two categories: the perception of true randomness (as may be experienced in Cage's music) and the perception of that which is designed to resemble randomness. Whether the unpredictability associated with randomness and quasirandomness is perceived in musics that utilise them depends largely on the compositional processes involved. For example, one can imagine an algorithmically generated pop song initiated with random or quasirandom seeds which sounds completely predictable.

Whereas the term "quasirandom" implies order that resembles randomness, "quasiorder" implies the opposite, i.e., randomness that resembles order. A simple example of quasiorder would be a pattern appearing in a series of coin tosses, e.g., HTTHTTHTTHT. Such a series of results might raise the expectation that the next throw will be a tail. Of course, providing the coin is unbiased, it could just as equally be a head, but the pattern begs a "T" to complete the repetition. It is the kind of randomness Brown would have

[10] Ellison, Carl, "Cryptographic Random Numbers", http://world.std.com/~cme/P1363/ranno.html

removed from a sequence to make it more disorderly. *Figure 1-2* shows four extreme conditions relating to the randomness of a piece of music and how it might be perceived:

Does the realisation of the piece require some sort of random input?		**Is randomness perceived in the output?**	
Yes	**No**	**Yes**	**No**
X	-	X	-
X	-	-	X
-	X	X	-
-	X	-	X

Figure 1-2: Comparison of random input against random output

Figure 1-3 attempts a more fluid depiction where the x-axis represents the compositional use of randomness (e.g., flipping a coin to determine note values) and the y-axis represents the differing perceptions. Quadrants 1 and 2 are linked in the sense that both use randomness in some way, but are perceived in completely different ways. By comparison, quadrants 1 and 4 arrive at similar results, both being perceived as random, but 4 manages this without any truly random element. Quadrants 2 and 4 are polarised on both accounts, like opposite sides of the same coin.

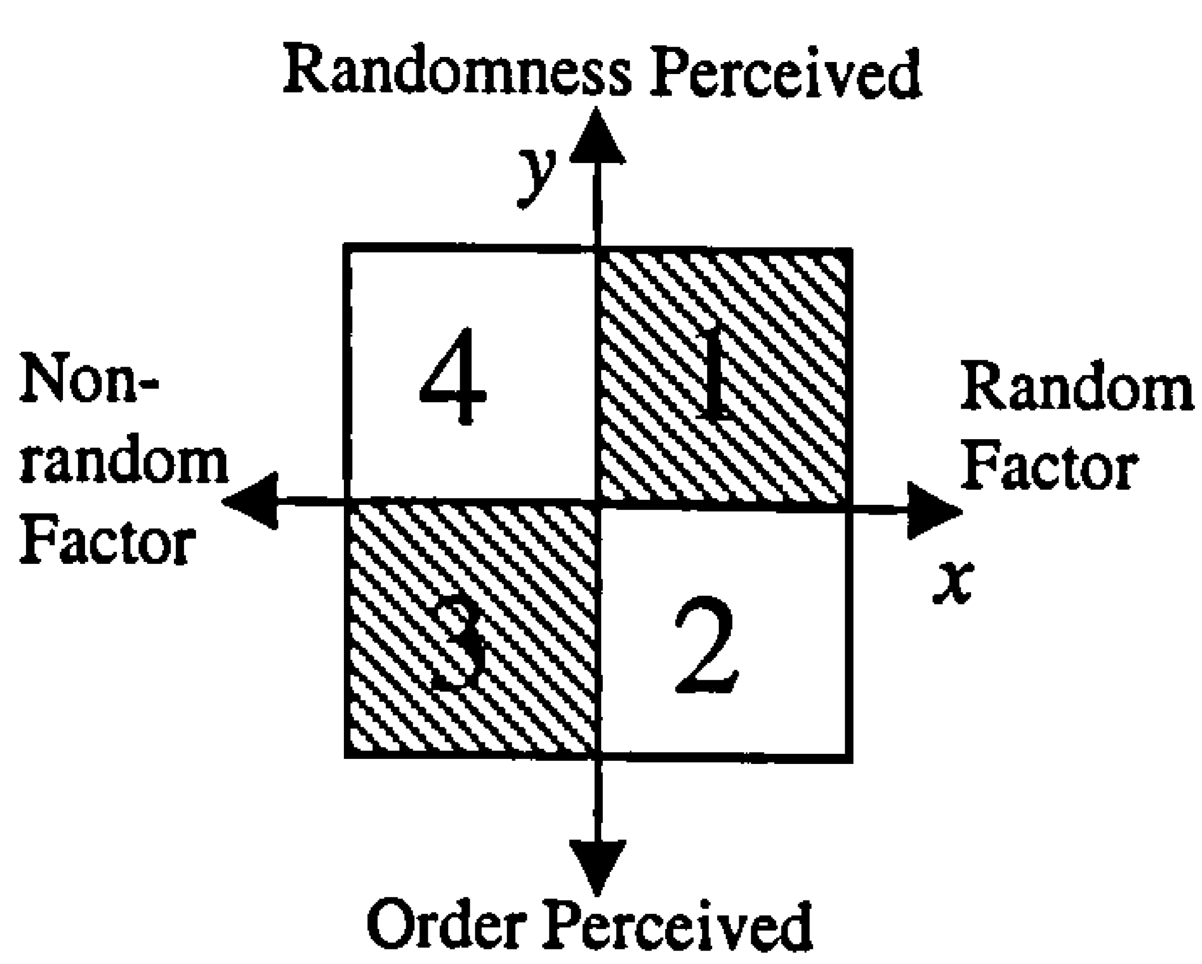

Figure 1-3: Differing perceptions of randomness and order in a musical system

Although this way of depicting the perception of randomness as it applies to music is useful, it only takes into consideration situations where music either does or does not sound random; it fails to allow for the in between values that may be experienced in music that exhibits perceivable characteristics of randomness *and* order. *Figures 1-4* and *1-5* show these relationships more realistically. In each of these hypothetical representations, the *x*-axis represents the amount of randomness within a system (the random factor), the *y*-axis represents the amount of control exerted by a system (the control factor) and the *z*-axis represents the degree to which randomness/order is perceived. All the points on the shaded squares (formed by the *x*- and *y*-axes at the midpoint of the *z*-axis) will be perceived as containing the qualities of both order and randomness in equal proportions, but will vary in the amount of control and randomness employed at the level of the process. Referring to *figure 1-4*, bringing the shaded square forward will decrease the sense of randomness and increase the sense of order; by moving it backward, the sense of randomness increases and the sense of order decreases.

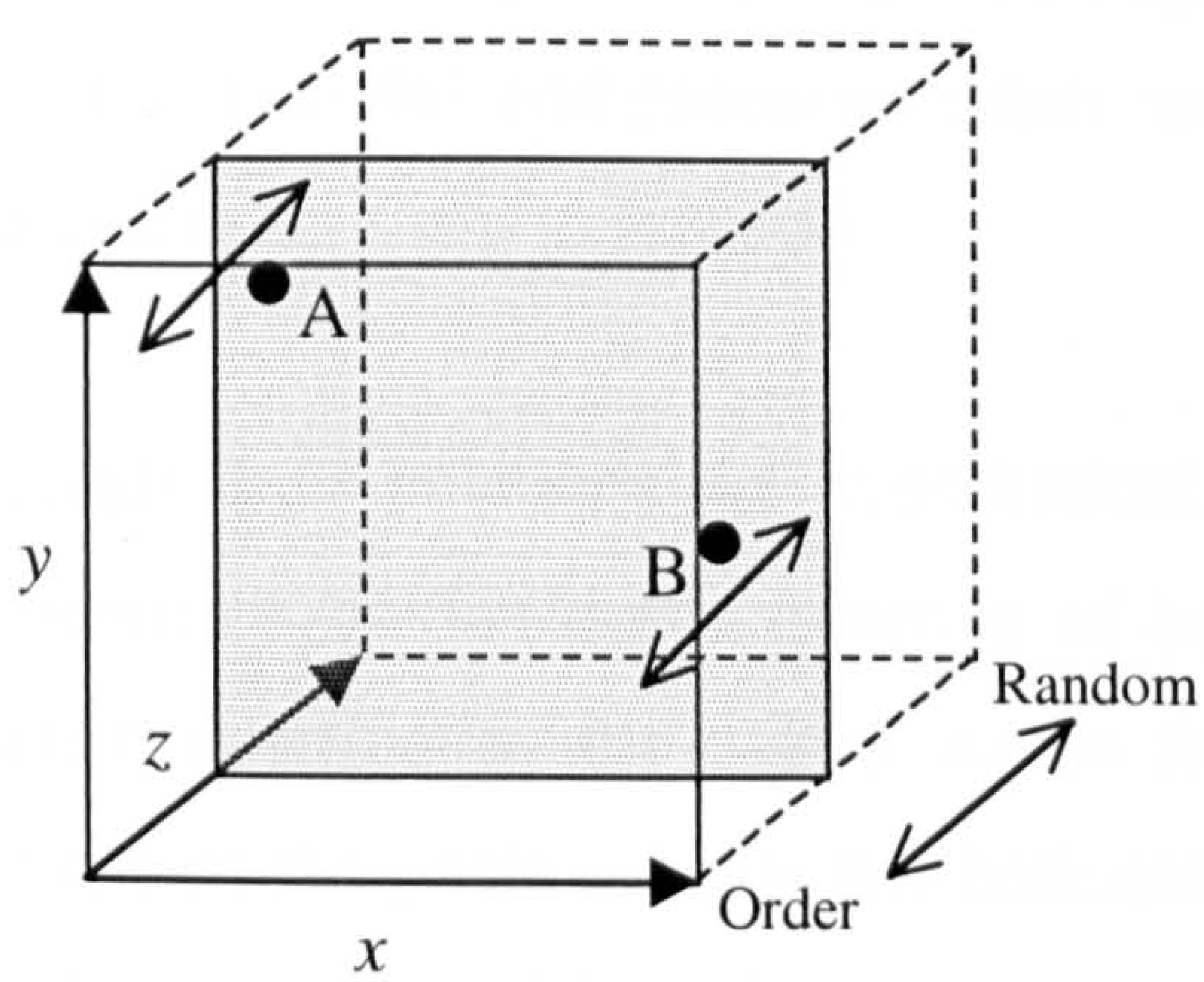

Figure 1-4: Degrees of randomness and order in process and perception

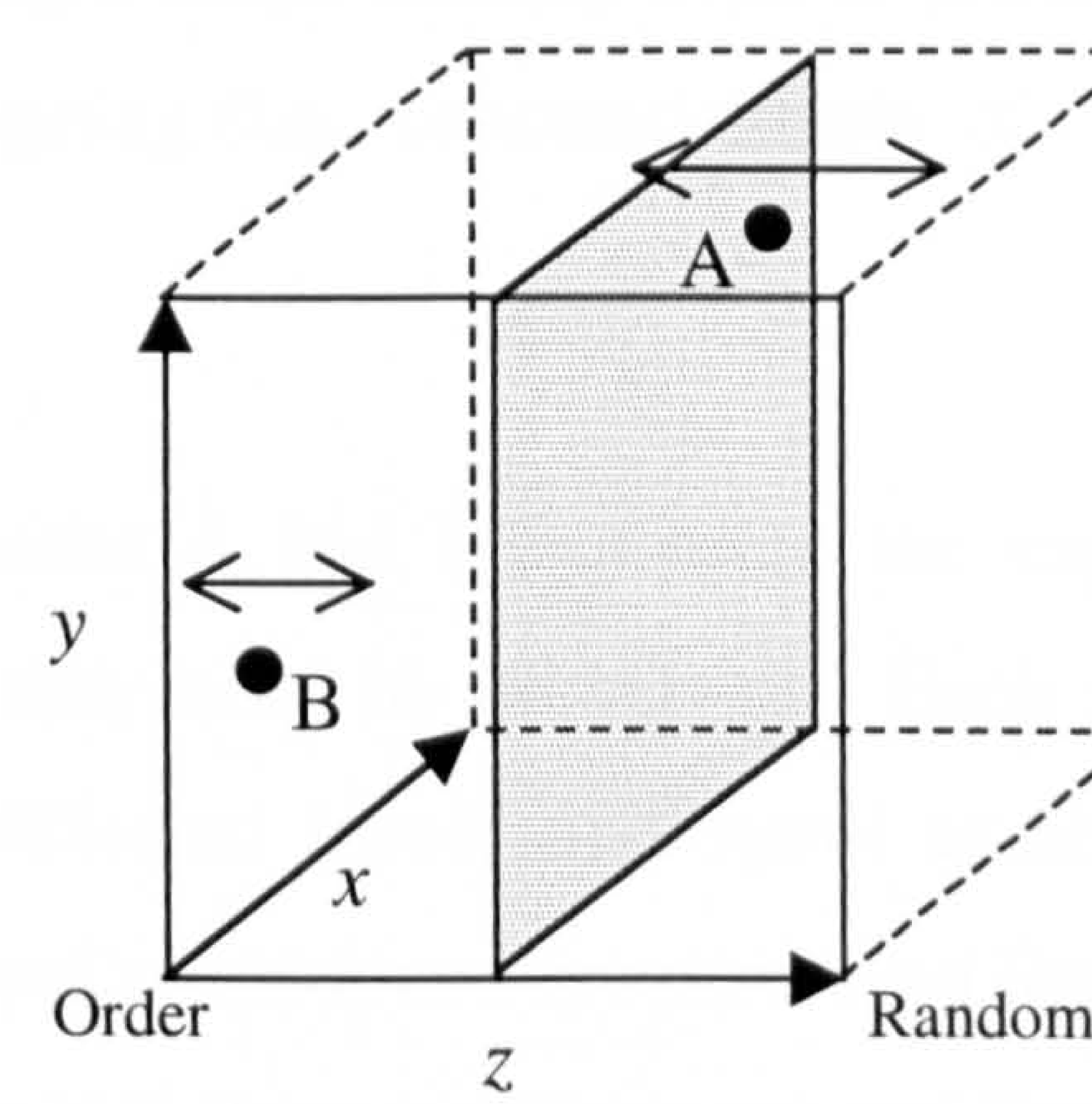

Figure 1-5: The same 3D image rotated 90° from right to left

Figures 1-4 offers a more useful representation than *figure 1-3* because it shows the dialectical relationship between randomness and order against that of process and perception. It leaves a number of ambiguities, nonetheless. For example, if order is perceived, is this down to the control factor or because the source of randomness contains a pattern? An answer can only be obtained by comparing the randomness going into the system with that coming out. Ambiguity also exists regarding what constitutes high- and low-levels of control, and whether it is possible to compare the degree of control imposed by one kind of system to that of another, bearing in mind different systems are realised using different techniques and resources, e.g., score-based systems usually require musicians, whereas formalised and algorithmic approaches may require computers. This technicality is overcome to some extent by defining the amount of control by the number of musical parameters influenced, rather than by how elaborate the process is. The majority of the experimental composition techniques examined in this thesis relate to pitch and time (rhythm/duration/structure), so the control factor for each experiment can be seen as relating to which of these are generated by the system and which are not. For example, in cases where pitches are randomly chosen, it may be argued the system has no control over pitch. As to what constitutes the amount of randomness in a system, this is defined as the difference between generative systems requiring a small random seed to produce a large amount of material, and processes where an ongoing (i.e., constant) supply of randomness is necessary for them to function.

Although their positions are hypothetical, points A and B represent the experimental compositions of this thesis in terms of how they may be perceived. Each takes up a different position on the y-axis due to the different levels of control exerted. Their positions on the z-axis indicate that both order and randomness are perceived (more so in A than B), with the double-ended arrows showing that these positions are not fixed, but free to move back and forth. The areas of PRN generation and cryptography covered in Chapter 4 fit near point A on the z-axis. In these experiments, a proportionally smaller amount of randomness is used than may be perceived, because the processes that take place are generative (i.e., the composition systems generate long pseudorandom sequences from small random seeds). With most of the parameter values derived from the process itself, the level of control is high. In contrast, the experiments that fit nearer to point B require more randomness, but may be perceived as being more ordered. This is applicable to the experiments conducted into quasiorder in Chapter 5, such as the random riff generator in which a continuous supply of randomness is made to appear ordered through repetition. The level of control over the parameters of pitch and rhythm is low, since, on the whole, they are chosen at random. Again, the position of B on the *z*-axis is more fluid in reality.

1.4 CRYPTOGRAPHY AND PRN GENERATION

My interest in the role unpredictability can play in music began with an appreciation of its use in the music of Frank Zappa, whose oeuvre always seemed to me to operate like a giant open form work comprising all manner of genres and experimental techniques, through which the listener may choose any number of avenues of exploration. Owing to his eclectic approach to composition, it is possible to find works that fit each of the quadrants described in *figure 1-3* (as will become clearer in Chapter 3). Zappa's popularity during the 1970s should not be underestimated; he was a huge star, capable of attracting tens of thousands of rock fans to see his stadium shows. As I grew more familiar with his albums and read about the techniques he employed, I began to realise that the unpredictability of his music was actually produced by a variety of means.

Zappa's potent combination of different composition and improvisation techniques undermine the standard practices of popular music. Indeterminacy, conducted improvisation, randomness, complex rhythmic subdivisions, musique concrète, as well as humour and iconoclasm, all contribute to the unpredictability of his music. From an historical perspective, this unpredictability has its origins in Zappa's plundering of twentieth century avant-garde music (a subject covered in depth in Chapter 2) but there is also a cryptic quality which is all his own. Often on a Zappa record, a seemingly insignificant piece of material is revealed elsewhere in his oeuvre to be extremely pertinent. His albums offer tantalising glimpses of things that appear meaningless until they appear again in a completely different context.

For those listeners who wished a greater understanding, Zappa would occasionally provide "continuity clues" to elucidate the unexplained details throughout his body of work. These clues acted as keys, unlocking hidden meanings in things that had previously been accepted on face value. The web of thematic links between albums, interviews, and just about everything else he involved himself in, acquired the term "conceptual continuity" (see page 112). Here, a connection with cryptography – the discipline dedicated to disguising meaning – can be made, and it is upon this that I launch my investigation into the musical application of techniques associated with cryptography (of which PRN generation plays an important role), where ordering processes designed to randomise materials are adapted for use in music.

Randomness plays a specific role in cryptography. An encryption algorithm (the name given to the process used to conceal information) is ideally initialised with a random seed or encryption key, known only by the sender and receiver. The longer and more complex the key, the less likely the encryption will come under attack. In cases where the key is short e.g., the Vigenère Cipher (a polyalphabetic substitution cipher, which uses twenty-six different versions of the alphabet to encrypt a message), the encryption algorithm operates like a PRN generator, creating a stream of randomness from relatively small supplies of actual randomness. Ellison sets out five categories of "cryptographic randomness" applicable to key generation. These are as follows:

> 1. Quantum randomness - to the best of our knowledge, this is *true* randomness.
>
> 2. Secret entropy – this is entropy that is not random but that is hopefully impossible for an enemy to capture and predict. Such entropy might be elements of the path of a user's mouse when the user is requested to move it around "randomly". [...]
>
> 3. Obscure complexity – this is entropy that appears random to a designer, not because it really is quantum randomness or secret entropy but rather because the designer doesn't understand the process that generates it. [...] To one who does understand the process producing these values, they might not be obscure at all.
>
> 4. random() function – this represents a source of algorithmically generated values that are declared random by a battery of statistical tests [and] can be thought of as a PRBG of no cryptographic value, usually using a very small seed (16 or 32 bits, in many cases).

> 5. Gee-wow complexity – this is complexity that looks random to a naive user. The most obvious example in this category is a chaos equation producing images of astounding complexity. [...] Chaos equations are examples of particularly insecure and rapidly searched PRBGs that were not even designed to be statistically random.[11]

What is interesting about these different types of "randomness" is the role that perception plays. Indeed, quantum randomness aside, the remaining examples would be better described as quasirandom because they achieve the appearance of randomness by either cloaking their point of origin in secrecy or by being very difficult to understand – a quality which depends as much on the inability of the perceiver to detect patterns as it does on the patterns' own complexity. An excellent musical example of this is the experience of listening to Cage's *Music of Changes* (1951) and Boulez's *Structures 1a* back-to-back. In spite of the opposite ideologies of the two composers (exemplified by Cage's use of chance operations to determine the parameter values and Boulez's use of a strict system of organisation based on series), both pieces sound remarkably similar to the extent that listeners may be hard pressed to differentiate which is random and which is not. Putting aside for one moment the actual intentions of *Structures 1a,* Boulez successfully manages to mimic randomness because his system of organisation operates in a way comparable to a basic PRN generator.

The term "cryptographic randomness" is used by Ellison to illustrate the type of randomness suitable for use within an encryption, but it could also be used to describe the appearance of the encrypted information itself. For example, it could be said that Zappa's "conceptual continuity" exhibits cryptographic randomness. My own investigations use the techniques associated with encryption algorithms to create formalised compositions. For the most part, however, these techniques are not used to hide messages within the music, but to generate quasirandom patterns. In Chapter 4, I make a comparison between the serial procedure employed by Boulez in *Structures 1a* and the Vigenère Cipher. Both share a number of similar features concerning the basic organisation of materials; for example, both set out material in a square formation, e.g., Boulez's matrices and the Vigenère

[11] Ellison, Carl, "Cryptographic Randomness", http://world.std.com/~cme/html/randomness.html

Square. Each of these is constructed in a similar way: Boulez transposes the series; Vigenère rotates the alphabet. Furthermore, both may be perceived as random, in spite of them being highly organised, non-random processes. As mentioned already, both behave like PRN generators. In the final part of Chapter 4, this area of exploration leads to the development of innovative methods of applying PRN generation to composition. The first of these are based on binary serialism. Note rows, chosen at random just like the seed values required by PRN generators, are represented in binary. Then, through the application of a technique similar to that used to create the Vigenère Square, a large binary grid is formed. This is used in a variety of ways to produce quasirandom material. In the second, a section of music undergoes an actual process of encryption. A melody by the Beatles is broken up into its separate parameters so that each may be encrypted using a different encryption technique. These are then recombined to produce what is referred to as a cipher-melody, designed to appear random.

In each case, the generation of quasirandomness is only part of the process; the second stage involves the generation of the musical structure. Such are the methods used to generate music from binary grids, that the structure is strongly connected to the grid's own construction; in other words, musical structure is unaffected by the seed value, taking on instead the block-like formation of the grid. This means a sense of order and randomness may be experienced together; a degree of structural predictability is balanced by the unpredictability of the quasirandom details. Even so, it is highly unlikely the system of generation will be detected here. Any musical patterns that appear out of this quasirandomness are illusions.

It is worth taking into account how little randomness is actually used in the processes of PRN generation referred to in Chapter 4. Returning to *figure 1-4*, it becomes clear that these techniques are situated near point A. That is to say: a small amount of true randomness (the random factor) can be used within a PRN generator (the control factor) to produce results that exhibit both randomness and order.

1.5 QUASIORDER: STANDARDISATION, REPETITION AND PREDICTABILITY

In the same way that something perceived as random might actually be derived from a non-random process, the reverse is also true, i.e., that something perceived as order might actually be random (see page 20). This type of quasiorder in which identifiable patterns are formed out of randomness, is pursued in the experimental compositions of Chapter 5. Again there is a link with cryptography, but this time with a process of decryption (rather than encryption) called a "brute force" attack – "brute force" because one way of cracking an encryption (of finding the encryption key) is to try all the possible options until the right one is found. A parallel can be drawn with the infinite-monkey theorem popularised by the physicist Arthur Eddington, who once stated that, "If an army of monkeys were strumming on typewriters, they might write all the books in the British Museum".[12] In fact, only one immortal monkey is actually required on the premise that, given an infinite amount of time, the number of monkeys becomes irrelevant; one will get there eventually. What can also be assumed about the products of the infinite-monkey theorem is that they are inherently meaninglessness to the monkey.

Unfortunately, the infinite-monkey theorem does not offer a workable alternative to writing music the normal way. Granted, seemingly identifiable patterns can and often do occur in performances of indeterminate works, but they can never be guaranteed; a different approach to quasiorder is therefore desirable. In Chapter 5, it is approached through an investigation of what contributes towards predictability in popular music. It has already been stated that a degree of randomness may be perceived in music when the listener is unable to predict highly complex patterns and that non-randomness (i.e., order) may be perceived when listening to chart-orientated popular music where patterns are easily

[12] http://en.wikipedia.org/wiki/Infinite_monkey_theorem citing Eddington, Arthur, *The Nature of the Physical World: The Gifford Lectures*, Macmillan, New York, 1929, p. 72.

detectable. How can randomness be introduced to popular music in such a way that it is perceived as predictable?

An answer may be found through the consideration of what is actually meant when popular music is referred to as predictable or formulaic, and here a basic grasp of Adorno's theory of popular music is beneficial. Instead of a popular versus art dichotomy taken for granted by "the music industry, critics, listeners, musicians, musicologists and students of culture",[13] Adorno believed music could be split into two contradictory components: that which affirmed the status quo and that which did not, e.g., the avant-garde,[14] implying that art music could often be just as formulaic as popular music. Adorno, in his famous 1941 essay *On Popular Music*, argues that popular music is pre-listened; it "listens for the listener" in order that it may be consumed as a leisure activity. As a product of the culture industry, it displays signs of "standardisation"[15] (a symptom of mass production) and "pseudo-individualisation"[16] (the illusion of free choice within a standardised system and that which places limitations on popular music in order to keep it popular). The reason why there is so little randomness in pop music stems from its dependence on these familiar characteristics. Adorno understood popular music to be predictable because of its reliance on simple formulas, which over the years had become ingrained into society, eventually becoming "naturalised". As a consequence of this "naturalisation", listeners today may be led to believe music has always started with an intro, followed by a verse and then a chorus, and the temptation to look beyond these restrictive notions is reduced further by a youth orientated entertainment industry strongly connected to the popular music industry. Although this argument faces difficulties in the case of experimental popular music from the 1960s onward, it still has some weight when applied to the predictability of chart-orientated pop music.

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[13] Middleton, Richard, *Studying Popular Music*, Open University Press, Milton Keynes, 2000, p. 35.
[14] Ibid., p. 34.
[15] Adorno, Theodor, "On Popular Music", *Studies in Philosophy and Social Science*, New York, Institute of Social Research, 1941, IX, 17-48, para. 3.
[16] Ibid. para. 23.

The idea that popular music is pre-listened is central to my investigation into the role that repetition plays in musical structures and how this can potentially be randomised to create quasiorder. In popular music, the multiplicities of repetition within familiar structures are chosen in favour over the singularities associated with randomness. In Chapter 5, I argue that singularities can still make a contribution, particularly where quasiorder is concerned. Middleton refers to the "unit of repetition" to describe the essential building block of a riff or a groove. He explains two kinds of repetition that act upon this, the principles of which I incorporate into a number of compositions where units of repetition are equated to randomly generated singularities. I approach quasiorder by randomly generating both the contents of the unit of repetition and how often it is repeated. This is initially achieved with the aid of an algorithmic random riff generator, realised on computer. The random riff generator requires a continuous stream of randomness (accounting for the position of B on the x-axis of *figure 1-4*). Although the generated sections of music are of unpredictable lengths (implying a random structure), the use of repetition creates a predominant sense of order, resulting in quasiorder. The process established here is then adapted so that musicians can replace the role of the computer. This involves a score-based system of colour coding to represent random pitches. Rhythm and structure are provided because in likening to the processes of PRN generation discussed in Chapter 4, which require random seeds, this process requires a degree of pre-established order. As mentioned on page 23, these composition techniques are situated best near point B on the three-dimensional representation (see *figures 1-4* and *1-5*), i.e., a relatively low degree of control over a greater amount of randomness.

The number of repeats is easier to predict in familiar structures. This is demonstrated with an analysis of the musical techniques of Jimmy Cauty and Bill Drummond of the pop group The KLF, and John Oswald, the creator of "plunderphonics". Cauty and Drummond's use of formulaic pop song structures results in repetition that never fails to meet the listener's expectations. On the other hand, Oswald abandons traditional approaches to structure and, as a result, the repetitions that occur within his music are highly unpredictable.

In the 1980s, Cauty and Drummond proved that the chart-orientated songs of the day (especially those produced by Stock, Aitkin and Waterman) could be reduced to a formula, using what they called the "Golden Rules". These are closely related to Middleton's definitions of repetition and Adorno's awareness of the standardisation (the set of clichés) in pop songs; the "Golden Rules" are themselves open to degrees of variation (e.g., how many repeats of a riff). I argue that their method is open to potential randomisation and to prove this I create a quasiordered pop song using the "Golden Rules" to impose a sense of order over random riffs. Cauty and Drummond's approach is all about constructing an illusionary order out of unrelated elements. Samples make up an important element, performing a structural role (e.g., when used as the unit of repetition) and emphasising the pre-listened nature of the music (it is easier to predict a piece of music if parts of it have been heard before). This last point ties in with Adorno's concept that popular music must be perceived as "natural music", where over time, patterns found in "classic hits" are repeated so often they become ingrained into society, becoming naturalised. Although there are many more popular music genres now than in Adorno's day, experimental popular music notwithstanding, the same old ideas are returned to time and time again. Cauty and Drummond's approach implies that this desire to repeat tried and tested musical devices now affects timbre, with sampling technologies enabling artists to accurately capture the sounds of past hits, so that a little of the "magic" might rub off on their own. With this in mind, I argue that in addition to Middleton's two kinds of repetition found in popular music, a third kind exists: samples of pre-existing material.

Cauty and Drummond are also making a satirical comment about popular music in the 1980s, which draws a parallel with Adorno's views of Tin Pan Alley, a particularly formulaic and commercial music that dominated the late-nineteenth and early-twentieth century. Adorno argues that the details and structure of love songs are mutually exclusive unlike in serious music where the details and structure drive each other along. According to Cauty and Drummond, elements of songs are interchangeable because they all exist in the same competitive market. This is embodied in their approach to using pre-existing materials, e.g., they may sample a drumbeat from one song, a bass groove from another, and so on. By imposing an overtly familiar structure the likelihood that these potentially random elements will be perceived as such is reduced, resulting in quasiorder.

Oswald favours the opposite approach. He uses pre-existing recordings but organises them in a quasirandom manner. In doing so, he identifies pop music's rigid musical structures; he approaches repetition by deconstructing it or, more accurately, by removing the sense of expectation attained with predictable musical structures. Cauty and Drummond, and Oswald, can be seen as the forerunners of the currently fashionable "bootleg" genre, which often merges together two or more pre-existing recordings by pop artists. Jokes are used, adding a degree of unpredictability; a track may begin in exactly the same way as a pre-existing recording, but the vocal will come from a different song altogether, e.g., the track "TLC v Human League" attributed to Girls on Top. Adorno's theory that the details of songs are not important is once again confirmed, with music and words from separate sources coming effortlessly together. Chapter 6 concerns the reception and perception of randomness. Part of this is based on my personal experiences of performing random music (e.g., the group pieces from Chapter 5) in local popular music venues.

1.6 SOCIAL RECEPTION AND PERCEPTION

Musical reception is strongly associated with social trends and affects musicians and audiences alike. It is often tempting to criticise the music industry for the way it seems to generate a continuing demand for "superficial" pop music with a relatively short shelf life, rather than pursue more "wholesome" objectives. But the reality is that many people find superficial pop music enjoyable, in full knowledge of its manufactured origins. Composers of experimental popular music may or may not choose to compete within this market, but if one's ideas are to reach a wider audience, a hit single can provide a lifetime's exposure and financial support. It is not a new strategy. As the revolutionary ideals of 1960s began to fade in the decades that followed, Zappa was not averse to using the profits of his rock albums to fund his orchestral projects. Some critics derided him for "selling out", but it allowed him to continue composing non-commercial music without government funding. Once inside the music industry, many of the problems faced by unsigned and un-represented musicians diminish. That said, it remains a competitive market, with the music industry more inclined to support writers of popular music than avant-garde composers. In a letter received May 2004, the Caragan Music Agency state:

> In this day and age it's very difficult to get the labels to invest in a project that won't see a long-term return. [...] The nature of the music business at the moment is fairly mercenary and there are an awful lot of artistes/writers out there that have a lot of potential but never seem to get anywhere. To really achieve something in this industry i.e., get a deal and have a hit you need to stand head and shoulders above the rest and at the end of the day it always comes down to the song. If you have a real killer song then the battle is half way over.[17]

My own experience of performing music with unpredictable elements in clubs and bars is that audiences are generally appreciative, a reaction I was not expecting when I first formed the group that has supported my research. Attempts at finding backing from within the music industry have been less successful. It could be argued that all genres face a degree of exclusion during their developmental stages. As it stands, there is no easy way to make a dent in any music scene; being unknown is a big obstacle in an image-obsessed society. On the club/bar circuit, the process of getting gigs a matter of pestering venues. If persuaded, the venue may offer a gig date, but will typically do nothing to promote it because it falls on a Tuesday when the venue is practically empty – the reason the gig was offered in the first place. Also, venues rarely pay unsigned groups (unless they play covers or happen to be a tribute band). Some London venues go as far as only booking groups willing to "pay to play", a system that favours those that can afford to be seen. These venues understand how important it is for groups to convey their image in a "fashionable" environment but are wary of bands with little or no following.

Malcolm McLaren argues that the emphasis on image stems from the competitive nature of the popular music industry. Marketing a group is a case of creating an identifiable brand and getting it noticed. As a result, the music industry has become increasingly dependent

[17] In spite of this sound advice, Caragan operates a dubious system whereby artists are required to pay for their demos to be listened to by "industry experts". I'll do it for free... richard_hemmings@yahoo.com

on televisual entertainment to advertise its products. But it is a two-way process. Programmes like *Top of the Pops* and those broadcast on MTV offer a certain type of entertainment, appealing to the broadest possible audience demographic. As a consequence, the music industry has to meet the criteria of programme makers. It seems that as a knock-on effect, young musicians are more inclined to gravitate towards the types of music that are supported by the mass media than those that question it. This could explain the difficulties I faced when forming my group. In Chapter 6, these issues are explored in greater depth, with reference to interviews with the individual members of my group and evidence gathered from audience feedback. I also refer to feedback from various sources within the music industry, which confirm its interests remain firmly with song-writing.

Whereas reception concerns the acceptance of music, perception is more about how the music is experienced. My investigation focuses on the perception of degrees of randomness in music. It attempts to form a better understanding of what constitutes the recognition of randomness and order. Psychological explanations, such as those offered by Gestalt theory, can help with the task of understanding why patterns sometimes appear in randomness. The interpretation of random notes as music is an illusion, brought on as the brain compares the randomness to previous musical experiences it has had. Out of this, a perception of either order or randomness will come. Falk and Konald's experiments into the perceived randomness of binary sequences (see page 232) scientifically prove that the perception of randomness is strongly associated with the ease with which information can be memorised, a process they compare with data compression. Patterns containing fewer alternations between 0 and 1 were found to be easier to memorise, and were less likely to be perceived as random. This idea stems from Information Theory, which states that a binary sequence is random if it cannot be compressed – a process of removing "redundancy" (reoccurring patterns) to decrease the size of the sequence. It can also be applied to music. Pop songs contain a lot of repetition, which can be compressed into a unit of repetition. They are easier to memorise because of this and unlikely to be interpreted as random. Serial music, on the other hand, usually contains difference, which is much harder to memorise.

There seems to be some psychological evidence to back up Adorno's theory of standardisation. Standardised music evokes standardised responses, allowing listeners to make predictions about a piece of music's direction. These learnt responses, based on musical memories, enable the listener to create an impression of how a composition will unfold. This idea is echoed in both Gestalt theory and more recently in Mari Riess Jones's theory of Dynamic Attending (see page 229).

The final stage of Chapter 6 involves a small survey into the perception of randomness in music. This survey is based on three pieces of music, each having a different position on *figure 1-4*. One of the pieces involves PRN generation and contains only a small amount of actual randomness, its seed. The perception of this piece is compared with a piece of chart-orientated pop music and a piece of free improvisation (non-random process/random-sounding). The results indicate that listeners have notions of degrees of randomness in music. The survey also investigates whether or not a musical education assists the perception of randomness. Respondents are divided into two groups according to the level of musical education they have received. The results suggest that musically trained individuals are slightly better at determining what is random and what is not.

CHAPTER 2

RELEVANT HISTORIES

This chapter is presented in three sections and offers a history of unpredictability in art and popular music. Section 2.1 sets out the early histories of chance in music, from its utilisation in musical parlour games to its contribution to the Dada movement. In section 2.2, the musical philosophies of John Cage and the group of composers linked with the New York Action School are discussed alongside the views of their contemporaries, in particular, Pierre Boulez and Iannis Xenakis. Boulez's serial technique is introduced because it provides the platform for investigations into quasirandom music conducted in Chapter 4 of this thesis, and Xenakis's stochastic music, because of its association with quasiorder, the subject of Chapter 5. Section 2.3 focuses on unpredictability in popular music, from its introduction in the late 1960s up to the present day.

Prior to the use of chance in music being an act of avant-gardism, it was sometimes a component of musical parlour games which used randomising procedures (usually the rolling of dice) to produce quasiordered compositions, i.e., randomness perceived as order. Throughout the 18th century, several of these games evolved, including one example by C.P.E. Bach. This is discussed in 2.1.1, along with a more famous example, the "Musikalisches Würfelspiele", which is often attributed to Mozart. In the absence of an autographed original, there exists a question mark over this claim; however, a different musical game in Mozart's hand does exist, and this is also explained.

Chance was not used in the creative sense until the start of the 20th century when it characterised the spirit of the Dada movement. In 2.1.2, a history of music in Dada is presented, focusing on the role of chance in the realisation of its philosophical objectives. Music was not a major component of Dada; Igor Stravinsky, Edgard Varèse and Erik Satie were associated, but never really part of the movement itself, which displayed its most radical tendencies in poetry and the visual arts. A key figure is Marcel Duchamp, an amateur musician as well as a professional artist, whose experimental compositions were some of the first to use chance with an artistic intention. This section explains two of his pieces, *La Mariée mise à nu par ses celibataires même. Erratum Musical* (1912) and *Erratum Musical* (1913*)*, which were designed to create unpredictable music.

The musical ideas of Duchamp (and Satie) were largely ignored until the early 1950s, when Cage employed chance operations to determine musical parameters and encouraged unpredictability in performance. This also marks the beginning of the period when the use of chance in music became a hotly debated issue amongst the avant-garde. Sometimes painted as dialectical opposites, Boulez and Cage initially struck up a friendship based on their joint musical interests. Between 1949-51, ideas and issues pertaining to musical automation occupied the thoughts of both men, eventually distilling into separate and opposing musical arguments concerning how to go about leaving compositional choices to chance, with Cage choosing Zen as his inspiration and Boulez adapting the ideas of Mallarmé. Xenakis's position is marked by his rejection of both of these options (although random seed values can be found in several of his works).

Section 2.2 begins by showing how the different compositional approaches demonstrated by these composers during the early 1950s can be represented in terms of true randomness, quasirandomness and quasiorder. Although Xenakis's early compositions may be perceived as more predictable than *Structures 1a* and *Music of Changes*, the nature of this is sometimes hard to define. This point is raised early on in the section, where a potential link to quasiorder is debated. In 2.2.1, Cage's approach is investigated, focusing on two of his works, *Music of Changes* and *4'33"*. These unpredictable pieces both employed chance operations during their construction stages. To Cage, chance played a crucial role in removing composer intention and letting sounds be sounds. His resolution to organise music by durations of sounds and silences, rather than by traditional harmony (which neglected the organisation of silences), encapsulated a new way of thinking about music that was influenced by Eastern philosophies. In addition, 2.2.1 contains a brief history of the New York based composers who shared Cage's interest in chance and the performance of unpredictable music.

Boulez achieved similar unpredictability in the serial piece *Structures 1a* and this accounts for his inclusion in 2.2.2. Serial music placed emphasis on structure and upon systems of organisation. In many ways it was a steppingstone on the way to fully automated composition systems and formalised music, subjects that resonate throughout this thesis, especially in connection to methods of PRN generation. As will be shown in Chapter 4, serial and formalised procedures can be used to create patterns that appear to be uncannily random, but are actually examples of quasirandomness.

Xenakis opposed Boulez's serial technique and Cage's use of chance. As a gifted mathematician and architect he conceived a way of using randomness, based on applied mathematics. This he applied to sound-based structures, creating elaborate pieces containing "sound masses", sonic transformations from order to disorder and visa versa. He termed this "stochastic music". The techniques used in two of his early works, *Metastasis* (1953-54) and *Pithoprakta* (1955-56), are discussed in 2.2.3.

Section 2.3 aims to establish an historical and cultural understanding of unpredictability in experimental popular music. Most general histories of popular music refer to experimentation in passing, nearly always focusing on the commercial success stories that represent the dominant culture. Bill Martin redresses the balance with a theory relating to Cage's aesthetic of non-intention. Martin argues that in progressive popular music, a dichotomy formed between those musicians who mastered their instruments and those who completely rejected this notion. A discussion of this is followed by a number of shortened histories of unpredictability in popular music, including those of The Beatles, The Grateful Dead, Brian Eno, David Bowie, Talking Heads, Sonic Youth, Stereolab and Mike Patton. This section also contextualises Chapter 3, which analyses Frank Zappa's music in considerable detail.

2.1 CHANCE AND MUSIC

It is interesting how, over the course of time, the role of chance in music has been transformed, from relatively innocuous uses in 18th century parlour games to more advanced applications within some of the 20th century's most groundbreaking avant-garde music. This transition from trivial to cutting-edge came about due to changes within musical philosophy; chance became important as a result of a dramatic transformation of Western aesthetic values, part of which involved the assimilation of Eastern philosophies.

2.1.1 Musical Dice Games and Puzzles

Long before chance provided Cage with a way of attaining non-intention, aleatory methods of musical production had existed in the form of musical games. One of the earliest examples is by Ghiselin Danckerts of the Franco-Flemish school of the 16th century. The so-called puzzle canon[1] is a four-part canon based on the text "Ave Maris Stella" and is shaped like a chessboard (see *figure 2-1*). The squares are moved around at the will of the players until they arrive at one of twenty possible solutions.

The idea of there being a number of "solutions" suggests that the results were not intended to sound as if they were arrived at by chance. This was a common idea in musical games, for example in "Einfall, einen doppelten Contrapunct in der Octave von sechs Tacten zu machen, ohne die Regeln davon zu wissen, W. 257 (H. 869)" by C.P.E. Bach (c. 1757). Roughly translated, the title implies a game where the player creates a double counterpoint within an octave, without needing to know the rules of composition. This implies the music produced is quasiordered, in so much as randomness is used, but the results are not intended to sound unpredictable.

[1] Elders, William, *Composers of the Low Countries*, Translated by Graham Dixon, Clarendon Press, Oxford, 1991, p. 74.

Figure 2-1: The Puzzle Canon Ave Maris Stella *by Ghiselin Danckerts*[2]

At around the same time a number of other composers were creating similar systems. Johann Philipp Kirnberger (1721–83) proposed using dice for musical composition in his book *The Ever-ready Composer of Polonaises and Minuets* (1757).[3] The introduction explained that users of the book would "not have to resort to professional composition". In 1783, Kirnberger published another game, designed to compose more complex sonatas,

[2] Ibid., p. 75.
[3] Wager, Willis, "Composers and Crapshooters", Carousel Publications, 2000. http://www.carousel-music.com/shooters.html

symphonies and overtures.[4] Austrian composer Maximilian Stadler (1748–1833) put together a set of musical bars and tables for generating minuets and trios with the help of dice. He referred to them as "Tables according to which one can toss off minuets and trios".[5] Each of these games produces pieces which could be described as quasiordered.

One of the most famous musical dice games is the "Musikalisches Würfelspiele" (Musical Dice Game), first published in Berlin in 1792. Often attributed to Mozart, it was actually published after his death and the lack of supporting evidence has led to the speculation that it was in fact ghost-written.[6] The game involves the creation of a sixteen-bar waltz, using two dice to randomly select from a choice of 176 numbered bars. The selection process incorporates two charts, each one measuring eleven rows by eight columns. To determine the first bar, a player would roll the two dice and subtract one from their total. This number would refer to the row number of the first column, in the first chart, which in turn would correspond to a bar of music. The process was repeated fifteen more times, counting through the columns in turn, until the piece was complete.

Although some doubt exists regarding the true author of the game, Mozart did create a musical game, but it was not played with dice. Noguchi states:

> Several kinds of "Musikalische Würfelspiele" were spuriously published under the name of Mozart and are designated as K. Anh. 294d/Anh. C 30.01 in the Köchel 6th edition of 1964. We can find an autographed, genuine musical game by Mozart in the Bibliothèque Nationale, Paris (Collection Malherbe) with signature *Ms. 253*, which is designated as K. Anh. 294d/516f but which was not recorded in Mozart's *"Verzeichnüß aller meiner Werke"*.[7]

On each side of this Paris manuscript, known as "Musical Game in C", K. 516f, there are eight staves. On one side, a six bar quotation from Mozart's *String Quintet in G Minor* takes up the top two staves. The remaining six staves of this side and seven staves of the other side are taken up with 103 two-bar long, single voice melodic patterns; each is

[4] Ibid.
[5] Ibid.
[6] Noguchi, Hideo, "Mozart - Musical Game in C K. 516f" http://www.asahi-net.or.jp/~rb5h-ngc/e/k516f.htm
[7] Ibid.

assigned a different letter (a mixture of upper- and lower-case letters are used) or number/letter (except for the first two-bar patterns on each side, neither of which are assigned a letter or a number).

> Mozart prepared many groups of two-bar melodies which may be selected at random [...] But since there are no instructions of how to select [...] the small or capital letters, or [...] the numbers either 1 or 2 (which correspond to the two bars of music), a complete explanation for this Musical Game has not been reported. [8]

Noguchi explains that the game might have revolved around converting words into music. The mixture of upper- and lower-case letters used suggests the possibility that the order of letters in peoples' names might have been used to construct pieces of music. Unfortunately, this remains speculation, but were it to be proven it would indicate that Mozart was not only interested in conveying hidden meanings through symbolism, as he had with the Masonic references found in the *Magic Flute* (1791), but also methods of concealing actual words within musical structures. Such methods are akin to those found in some forms of cryptography, most noticeably Simple Substitution Ciphers (see page 123).

2.1.2 The Dadaists

Sometime around 1915, not long after the outbreak of World War I, a new art movement called Dada emerged in Zürich. Many of its founding members were emigrants wishing to escape the political upheaval in Europe. As a neutral country, Switzerland offered freedom, especially in Zürich, which quickly became a hotbed of creative activity. Central to the movement was the Cabaret Voltaire, a venue opened by Hugo Ball, where aspiring young artists with a desire to outrage the establishment could offer contributions and ideas. The success of events, such as the evening devoted to Ball's abstract poetry,[9] was measured in

[8] Ibid.
[9] "Recovering from their initial bafflement at this totally new sound, the audience finally exploded... [It] was the climax of Ball's career as a Dadaist". Richter, Hans, *Dada: Art and Anti-art*, Thames and Hudson, London, 1997, pp. 42-43.

terms of audience reaction; loud and vivacious heckling from an audience always indicated a triumph.

At its inception, the main focus of Dada was prose and poetry, and new visual media such as photomontage and constructions made out of any materials that were available (e.g., bits of string, pieces of wood and used bus tickets). Dada abandoned traditional Western aesthetics in favour of "anti-art", with the aim of finding new forms of expression.

One of the turning points was the idea that chance could be used as a "new stimulus to artistic creation".[10] Hans Richter tells the story of how Dada painter and collagist Hans Arp supposedly came to use chance techniques for the first time. Dissatisfied with a drawing he had been working on for some time, he ripped it up, allowing the torn pieces of paper to fall to the floor. Later, he noticed that the pattern they formed on the floor seemed to express everything he had been striving for. Tristan Tzara was to use a similar technique in the construction of poems, cutting out individual words from newspaper articles and letting them flutter onto a table. Where the words fell would constitute a poem. In his *Dada Manifesto on Feeble Love and Bitter Love* delivered to an audience at the Galerie Povolozky, Paris, in December 1920, a variation of this technique was explained. It reads like a recipe or the instructions to a *Blue Peter*[11] "make", albeit somewhat more cynical:

> To Make a Dadaist Poem
>
> Take a newspaper.
> Take some scissors
> Choose from this paper an article of the length you want to make your poem.
> Cut out the article.
> Next carefully cut out each of the words that makes up this article and put them all in a bag.
> Shake gently.
> Next take out each cutting one after the other.
> Copy conscientiously in the order in which they left the bag.
> The poem will resemble you.

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[10] Richter, Hans, *Dada: Art and Anti-art*, Thames and Hudson, London, 1997, p. 51.
[11] *Blue Peter* is the BBC's longest running children's television programme. It is famous for its "makes" which usually involve used washing-up-liquid bottles and sticky-back-plastic, materials the Dadaists would most certainly have approved of.

> And there you are – an infinitely original author of charming sensibility, even though unappreciated by the vulgar herd.[12]

Arp, however, backtracked from his discovery, preferring instead to organise materials so that they might appear random, a process that involved his own judgement.[13] To this end, Dada can lay claim to works produced by both randomness (Tzara) and quasirandomness (Arp).

> Chance appeared to us as a magical procedure by which one could transcend the barriers of causality and of conscious volition, and by which the inner eye and ear became more acute, so that new sequences of thoughts and experiences made their appearance.[14]

The development of new musical ideas was not a huge concern of the movement. Tzara, who was at the forefront of Dada during its early years, never once mentioned music in any of his manifestos. Much of the music that took place during the early days of the Cabaret Voltaire was provided to contrast with an evening's more radical elements. The show's luminary, Emmy Hennings, would perform well-known cabaret songs from Munich and Paris, most likely accompanied by Ball on the piano. More unusual acts included a balalaika orchestra, a group of dancing Dutch banjo and mandolin players, Polish folk singers and even Arthur Rubinstein performing works by Ravel, Saint-Saëns and Debussy; Negro chants were performed by dancers dressed in funeral robes.[15] In short, music was important, but its definition was never really expanded. There was never really a true Dada composer, although some famous names were associated. Some of Stravinsky's works were performed at the Cabaret Voltaire, and he was published in the Dada magazine *Littérature.* In 1919, his *Le Chant du Rossignol* was performed at the *First Dada World Congress*, in Geneva. Edgard Varèse's association comes from the fact that he once signed a Dada treatise, only to regret it later,[16] whereas Erik Satie is connected by his Dada-like

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[12] Tzara, Tristan, *Seven Dada Manifestos*, translated by Barbara Wright, John Calder, London, 1977, p. 39.
[13] Richter, Hans, *Dada: Art and Anti-art*, Thames and Hudson, London, 1997, p. 60.
[14] Ibid., p. 57.
[15] Green, Malcolm, preface to Huelsenbeck, Richard (editor), *Dada Almanac*, reprinted by Atlas Press, London, 1993, p. iii.
[16] Landy, Leigh, "Duchamp: Dada Composer and his Vast Influence on Post-World War II Avant-garde Music", *Avant Garde, no. 2*, p. 132.

ideas and collaborations with Dadaists rather than by any direct involvement (although he did appear in and provide the music for Rene Clair's 1924 Dada film, *Entr'acte*). Three members of the group of young French composers *Les Six*, Georges Auric, Darius Milhaud and François Poulenc, had their music performed at an exhibition accompanying the first public Dada event in Paris. Also featured were works by Satie and Henri Cliquet.[17] *Les Six* developed their own forms of musical expression, often witty and satirical, drawing upon the absurdist humour that perpetuated the movement, rather than pushing any musical boundaries.

> Poulenc seized on the opportunities a vulgar form presented to satirise convention or to cause a jolting double-take, while Milhaud, in his sleazy jazz ballet *La création du monde* (1923) took advantage of the early force in Afro-American music.[18]

There are only a few chance-based compositions from the Dada period. One of the reasons for this may have been that the randomisation of words was considered a greater challenge, as Richter states:

> Sounds are relatively easy to put together, rhythmically and melodically, in chance combinations; words are more difficult. Words bear a burden of meaning designed for practical use, and do not readily submit to a process of random arrangement.[19]

Nonetheless, a handful of random compositions directly associated with Dada do exist. Georges Ribemont-Dessaignes taught himself basic music theory and prepared some unpredictable etudes, such as *No Curly Chicory!* which was composed by choosing notes at random. It received its premiere performance in 1920 at a Paris Dada event. At the piano sat the concert professional Marguerite Buffet, with the composer by her side. The audience erupted into jeers and whistles, causing Ribemont-Dessaignes to conclude that the piece was "curiously effective".[20] He asserted his position as the only composer at the Cabaret

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[17] Richter, Hans, *Dada: Art and Anti-art*, Thames and Hudson, London, 1997, p. 173.
[18] Griffiths, Paul, *Modern Music: A Concise History*, Thames and Hudson, London, 1994, p. 110.
[19] Richter, Hans, *Dada: Art and Anti-art*, Thames and Hudson, London, 1997, p. 54.
[20] Huelsenbeck, Richard (editor), *Dada Almanac*, reprinted by Atlas Press, London, 1993, p. 88.

Voltaire, on the grounds that nobody else was interested.[21] There is also evidence of different classical piano compositions being performed simultaneously at the Cabaret Voltaire.[22]

Duchamp composed three concept pieces that employed chance: *Erratum Musical* (1913), *La Mariée mise à nu par ses celibataires même. Erratum Musical* (*The Bride Stripped Bare by her Bachelors Even. Musical Erratum*, 1912), and *Sculpture Musical* (1913). The former two pieces listed above are aleatory, with Duchamp making scores for them (although *La Mariée* is incomplete), whereas the latter is a description of an idea for a musical event, written on a small piece of paper. Both *Erratum Musical* and *Sculpture Musical* were parts of *The Green Box* (1934), the collection of over one hundred pages of notes relating to his unfinished major work, *The Large Glass* (alternatively titled *La Mariée mise à nu par ses celibataires même*, 1915-23).[23]

Erratum Musical is for three voices; each part consists of twenty-five pitches drawn at random from a hat and recorded on manuscript paper in the order they are chosen, one syllable assigned to each note:

> Each note is sung slowly – the singers follow the same tempo. The text for these random harmonies is the dictionary definition of the verb to print (imprimer): "Faire une empreinte marquer des traits une figure sur une surface imprimer un sceau sur cire" (To make an imprint mark with lines a figure on a surface impress a seal on wax). [...][24]

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[21] Landy, Leigh, "Duchamp: Dada Composer and his Vast Influence on Post-World War II Avant-garde Music", *Avant Garde, no. 2*, p. 131.

[22] Huelsenbeck, Richard (editor), *Dada Almanac*, reprinted by Atlas Press, London, 1993, p. iii.

[23] The notes contained in *The Green Box* are complementary to *The Large Glass* and are often considered to be an integral part of it. They vary from scribbles on scraps of paper to complete essays. In some ways they generate more questions than answers; however, they do provide an account of the subjects contained in the *Large Glass* and details of the procedures that went into its creation, some of which involved chance. For example, Duchamp used a toy canon to fire nine matches with painted tips at the work, drilling through the glass where each of them hit (the so-called "nine shots"). Duchamp also incorporated his unit of measurement, the "standard stoppage", which was a dropped meter of string, frozen in paint and cut to make a kind of wobbly ruler. These were used in the "capillary tubes" section of the *Large Glass*.

[24] Landy, Leigh, "Duchamp: Dada Composer and his Vast Influence on Post-World War II Avant-garde Music", *Avant Garde, no. 2*, p. 134. Duchamp removed the punctuation of the dictionary definition, creating one sentence.

The piece allows for some interpretational leeway, e.g., if pitches turn up outside the singer's range they may be performed approximately.

Duchamp's unfinished score of *La Mariée* contains a description of how the piece should be carried out. It can be performed on a player piano, mechanical organ or any other instrument that suppresses virtuosity. It may also be performed on new and unrecognisable instrument(s) or by disguising the sound of known instruments. In addition, some peculiar bits of equipment are required, adding a typically Dada visual aspect to the performance: a large funnel, five toy train wagons (open and connected) and numbered balls, one for each timbre/pitch the instrument(s) can produce. The performer assigns a time period to each of the five wagons. The balls are then poured into the funnel and allowed to fall at random into the wagons as they are pulled underneath, so that, although the performer is not in control of the field of pitches (balls which miss the wagons are discounted) the performer may control the order in which pitches are selected from the wagons. Because of this, *La Mariée* is indeterminate as well as aleatory. Upon completion of this task, balls are removed from each wagon, at a rate proportional to the time period allocated to the wagon. This produces an effect where "numerous balls in the wagon = less proportional space between notes within the time period than in the case of a few balls".[25] With dynamics left to the performer to decide, the final result is a piece of music in five sections. Duchamp, however, allows the process to be repeated any number of times. Landy states:

> The Dada spirit is reached in this work as the local decisions are made by the falling balls [...] and as musical expectation is lost due to the combination of the antivirtuosic instrumental approach as well as the lack of any form of development.[26]

Out of these two random compositions, it is this second one that has experienced the most performance[27] and, it could be argued, has had the more resounding impact on music as a whole. Compared to other pieces from the same period, though (e.g., Stravinsky's *Le Sacre du Printemps* (1913), which received its premiere performance in the same year as *Erratum*

[25] Ibid., p. 135.
[26] Ibid.
[27] Ibid.

Musical), Duchamp's pieces sound rather banal. This probably explains why his ideas were slow to be taken up by musicians and composers, in spite of their groundbreaking nature. The application of chance to composition processes did not seriously penetrate music until the early 1950s and later in the Fluxus movement, by which time the initial Dada movement had dissolved.

At around the same time Duchamp was experimenting with chance in music, Percy Grainger was also investigating its potential, but from a completely different perspective. Grainger was not a Dadaist at all. His interest in chance can possibly be traced to the programme notes to a concert performance of his *Scotch Strathspey and Reel*, in which six Scottish and Irish folk songs are interweaved. In the notes, he describes an imaginary scene where a "room-full of Scottish and Irish fiddlers and pipers, and any nationality of chanty-singing deep-sea sailors" would, through "polyphonic harmonic free improvisation", perform music containing "harmony and rhythm".[28] Bird writes that Grainger

> [...] was fond of incorporating passages where melodic lines or chordal sequences are sent off in different directions without apparent regard to each other. [...] Perhaps the most important consequence of this theory was the idea of planned improvisation and indeterminacy.

In 1912, Grainger began working on *The Random Round*. As with the imaginary folk piece described above, it aims to develop a sense of harmony through improvisation. *The Random Round* comprises several different sections, separated by a Javanese gong. Of the piece, Bird writes:

> Within each section the thematic material is treated in ten to twenty forms and, to a harmonic ostinato strummed on a guitar, the vocalists and/or instrumentalists are at liberty to take any variant at any time at any speed, and jump to another at will (but at the correct pitch).[29]

In many ways, this piece bears the hallmarks of a quasiorder process, and is especially pertinent in view of the investigations that take place in Chapter 5. A "round" is by

[28] Bird, John, *Percy Grainger*, Paul Elek, London, 1976, pp. 145-146.
[29] Ibid.

definition repetitive, and it is because of this that the perception of unpredictability is diminished, resulting in a more orderly experience.

2.2 CLASHING PHILOSOPHIES: CHANCE OPERATIONS, SERIALISM AND STOCHASTIC MUSIC

As the 20th century progressed, chance became increasingly relevant to composers intent on breaking from traditional ideas of what was expected from a piece of music. Cage, Boulez and Xenakis became particularly embroiled in philosophical arguments over whether or not music should be left to chance, with each composer taking a different stance. In Chapter 1, Boulez's *Structures 1a* and Cage's *Music of Changes* were classified according to the compositional processes they employed, with the former compared to PRN generation (a quasirandom process) and the latter distinguished by its use of chance (a random process). Understanding Xenakis's music in such a way (particularly the early pieces which can be seen as a response to the serial and chance techniques of the day) is more complicated. For example, formalised techniques were used by Xenakis to generate sound masses (see page 65) consisting of many randomly behaving elements, i.e., individual instrumental lines that appear to be on a random walk.[30] These techniques might be described as quasirandom, since they involve algorithmic ways of creating randomness. The complication occurs because the aggregate experience of these random elements may be the perception of an identifiable musical shape, i.e., the music sounds ordered to a degree.

More specifically, the types of shapes found in pieces like *Metastasis* and *Pithoprakta* (see page 68) are determined at the pre-compositional stage by sets of conditions that impose degrees of order. This is not to say these pieces are as predictable as most popular music,

[30] A random walk, in the technical sense, is a formalisation based on the idea of taking successive steps, each in a random direction. A random walk is a stochastic process. http://en.wikipedia.org/wiki/Random_walk

but that by using identifiable shapes they are more so than pieces like *Structures 1a* and *Music of Changes.* That Xenakis was thinking about shapes is clear from the following:

> One thing I learned from architecture which is different from the way musicians work is to consider the overall shape of the composition, the way you see a building or town. Instead of starting from a detail, like a [musical] theme, and building up the whole thing with rules, you have the whole in mind [...].[31]

What one hears then, are sonic shapes forged out of many individual elements seemingly moving at random (unlike *Structures 1a* and *Music of Changes,* where the listener is presented with a mass of random-sounding notes and chords, but very little shape-wise). This interpretation compares favourably with that of quasiorder, described in Chapter 1 as randomness perceived as order, but forgoes the idea presented in the previous paragraph that the individual elements in question behave in a quasirandom manner, rather than a truly random one. It raises the question: is quasirandomness perceived as order "quasiorder" or "true order"? One is still drawn to quasiorder on the simple grounds that quasirandomness is not intended to appear ordered.

For now, then, it is sufficient to say that quasiorder is a factor in Xenakis's music associated with how the types of shapes (the details of which are quasirandom) create patterns of predictability in the general scheme of things. Since Xenakis opposed the approaches of Cage and Boulez during the 1950s it is interesting to compare *Metastasis* and *Pithoprakta* to *Structures 1a* and *Music of Changes.* The diagram below shows how the different approaches of Boulez, Cage and Xenakis in these pieces relate to each other in terms of process and perception. Each composer/technique takes up a separate quadrant, or two in the case of Xenakis. Cage (chance operations in *Music of Changes*)=quadrant 1; Boulez (serial techniques used in *Structures 1a*)=quadrant 4; and Xenakis (stochastic processes used in *Pithoprakta*)=quadrants 2 and 4. Each of these opposes quadrant 3 (non-random in process and perception, e.g., Stravinsky's *Agon* (1953; 1956-57)).

[31] Xenakis interviewed by Matossian, N. in 1977, cited by Beilharz, Kirsty, "Designing Sounds and Spaces: Interdisciplinary Rules & Proportions in Generative Stochastic Music and Architecture", *The Journal of Design Research,* Vol. 4, Issue 2, 2004. http://jdr.tudelft.nl/articles/issue2004.02/Art2.html

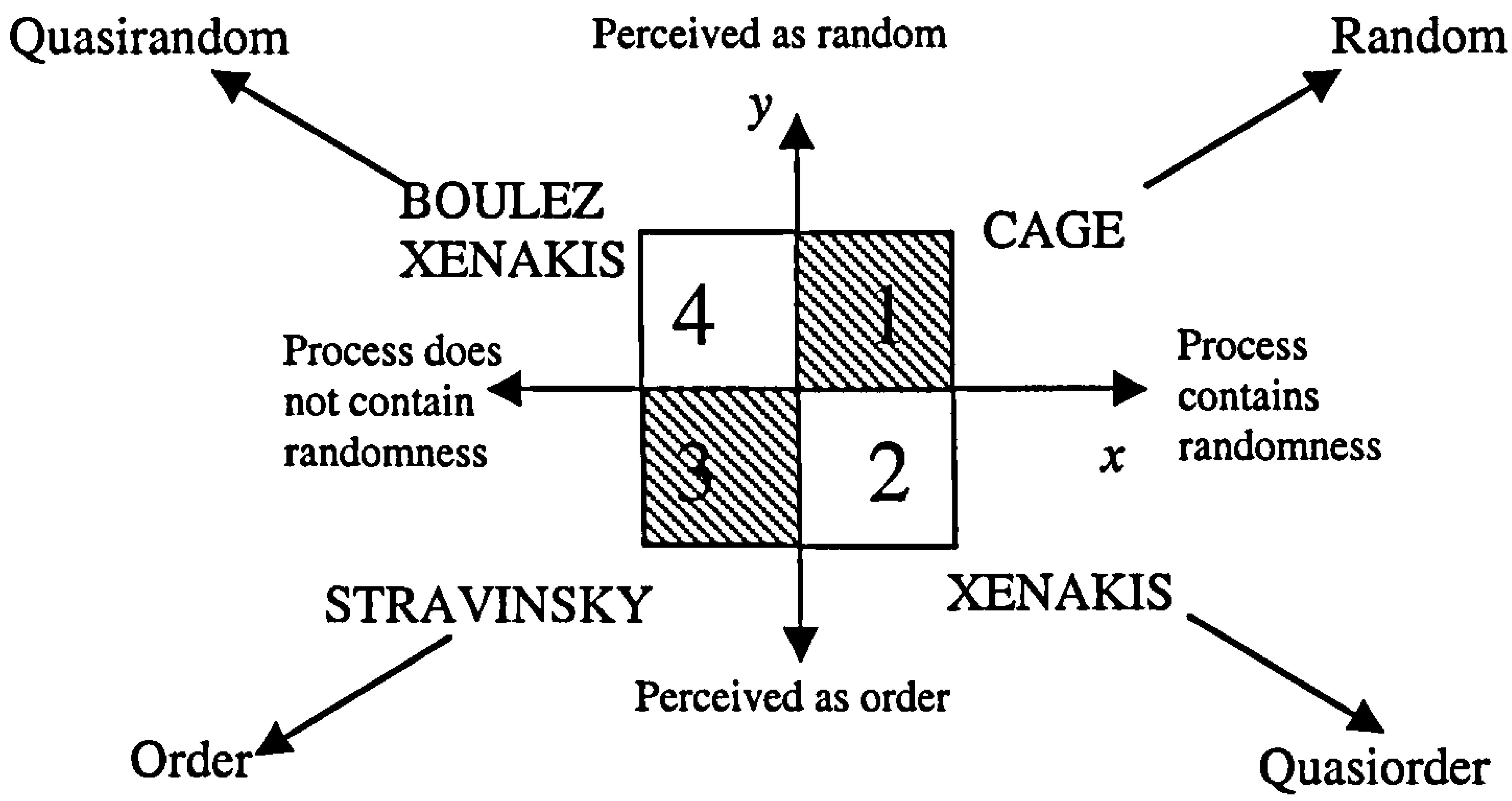

Figure 2-2: Randomness and order in process and perception

This representation is very specific to the early 1950s. In fact, things get more complicated depending on when one looks. Later pieces by Boulez are still highly ordered but contain distinctive shapes, e.g., the use of arpeggios in *Répons* (1981-84). In Cage's "number" pieces, both degrees of order and randomness may be perceived. These pieces take a fixed total duration and divide it into shorter durations, which may either be fixed (i.e., a sound must begin and end at a specific point) or flexible (i.e., the period of time is still fixed, but the start and end points of the sounds made within this are not specified). The field is therefore provided, but the details within (including which instruments the piece is performed by) are unpredictable. Fixed durations aside, much of the order perceived is quasiorder.

Other approaches to quasiorder are investigated in Chapter 5. Some of these involve the randomisation of riffs, on the basis that repetition can be used to diminish the sense of randomness. They differ from the Xenakis in that they use familiar structures to define how the details are perceived, rather than having the details define how the structure.

2.2.1 John Cage

Cage studied Zen philosophy with Daisetz Suzuki and applied his teachings to music. Zen led him to the conclusion that "Sounds should be honoured rather than enslaved".[32] He realised that chance could free the composer from controlling sounds and free the music from the personal tastes of the composer. Cage first utilised chance methods of composition in the final movement of the *Concerto for Prepared Piano and Chamber Orchestra* (1951), where decisions regarding structure, the durations of sounds and silences, were made using the Chinese Taoist "book of changes" or *I Ching*. His first fully composed piece using this method, the *Music of Changes* (1951) was soon to follow.

> *Music of Changes* is a chance composition, but it is not indeterminate. It was notated using chance operations, but once the score was complete, the notation was to be played as written. [...] Chance music is here defined as music in which chance operations are used to determine its notation and the score determines the greater part of how the music is to be performed. Indeterminacy is defined as music in which the composer and /or performer cannot foresee the greater part of the result of performance, which is made up of non-intentional sounds.[33]

At its first complete performance on 1 January 1952, *Music of Changes* was paired with Boulez's *Structures 1a*. The two were similar in the sense that they both approached music as a combination of parameters and sounded unpredictable; but where Boulez used serial principles of organisation, Cage used chance operations determined by *I Ching*. Although duration detail is present, *Music of Changes* does not contain bar-lines to indicate meter; instead, it uses the length of the staff as an indication of "time to be filled". Throughout the 1950s this technique became known as "space-time notation",[34] and it resulted in a specific kind of performance where, as Cage stated, the speed of travel through the space would be unpredictable,[35] although this was not the case with the *Music of Changes*.

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[32] Kostelanetz, Richard, *Conversing with Cage*, Limelight, New York, 1988, p. 232.
[33] Soloman, Larry, *The Sounds of Silence: John Cage and 4'33"*, para. 42.
http://www.azstarnet.com/~solo/4min33se.htm
[34] Griffiths, Paul, *Modern Music and After: Directions Since 1945*, Oxford University Press, Oxford, 2002, p. 26.
[35] Cage, John, *Silence: Lectures and Writing*, Calder and Boyars, London, 1973, p. 57.

2.2.1.1 Rhythmical Structure

Soon after his book of *Sonatas and Interludes* for prepared piano (1946-48) had been completed, Cage delivered a paper entitled "Defence of Satie" in which he criticised the dodecaphonic system of composition for "not having enough of nothing in it".[36] Cage argued there had been only one development in structure since Beethoven and this could be perceived in the music of Satie and Webern.

> With Beethoven the parts of a composition were defined by means of harmony. With Satie and Webern they were defined by means of time lengths. The question of structure is so basic, and it is so important to be in agreement about it, that one might ask: Was Beethoven right or are Webern and Satie right? I answer immediately and unequivocally, Beethoven was in error [...].[37]

In *First Construction (in Metal)* (1939) and the prepared piano pieces, Cage displayed an increasing interest in percussion-based sonorities, where the use of pitch information is replaced by an emphasis on timbre. In light of this, his need to structure music by means other than harmony becomes clear. He goes on to explain that duration is the only musical parameter shared by sound and silence, and that:

> There can be no right making of music that does not structure itself from the very roots of sound and silence – lengths of time.[38]

This idea was eventually taken to extremes in the piece Cage is most famous for, *4'33"*.

2.2.1.2 Silence and *4'33"*

On 29 August 1952 at Woodstock, New York, *4'33"* was performed for the first time; at the piano was David Tudor. The score, written for any instrument or combination of

[36] Ibid., p. 79.
[37] Kostelanetz, Richard (ed), "Defence of Satie", *John Cage*, Praeger Publishers, New York, 1970, p. 80.
[38] Ibid.

instruments, specified three silent movements of different lengths; consequently a stopwatch was required to time them. Cage's instruction "tacet" (i.e., not play), resulted in Tudor lowering and raising the piano lid to signify the opening and closing of each movement. To indicate to the audience the changing of the movements, Tudor turned the pages of the score.[39]

To this day, *4'33"* remains one of the most controversial pieces of twentieth century music. Cage had declared earlier in his career that he wished to compose a silent piece of around three or four-and-a-half minutes, the standard length of "canned music", and sell it to Muzak Co.[40] It draws close comparison to *Musique d'ameublement* (1920) – Furniture Music – composed by Satie, who desired a type of music that was to be performed but not listened to.

The unusual duration of *4'33"* can be explained by the fact that the piece came into existence at around the same time that Cage was composing *Music of Changes*. Rather than assign each of the three movements an arbitrary duration, Cage turned once again to his number charts and *I Ching*. The procedure was similar to that which had been used to create *Music of Changes*, where he had used twenty-six charts. In *4'33"* there was no need to generate pitch information or any other parameters associated with sound, therefore Cage only required the use of the eight duration charts. Its construction was therefore aleatory, since "chance operations" were used to derive its rhythmical structure. At its premiere, the lengths of the three movements were 30", 2'23" and 1'40", but this score later went missing. A later version showed different proportions, suggesting Cage recomposed it.[41] Building a silent piece of music duration-by-duration, a relatively time consuming, if not completely absurd process (given that it is commonly perceived as noteless), places *4'33"* firmly in the tradition of Dada. But humour aside, in performance it was steering towards

[39] Whereas later issues of the score consisted of just one page, the score used by Tudor at Woodstock included the note stems of the rhythms, indicating the durations arrived at through chance operations.
[40] Cage, John, *For the Birds: in Conversation with Daniel Charles*, Marion Boyars, Boston, 1981. p. 43.
[41] Soloman, Larry, *The Sounds of Silence: John Cage and 4'33"*, para 32-36.
http://www.azstarnet.com/~solo/4min33se.htm

something more provocative; the idea that sounds from outside a work could make a contribution to it. In the case of *4'33"*, the sounds come from the audience in the concert hall or from whatever environment it is performed in. This was a landmark in Cage's oeuvre, but it was not a completely new idea; Russolo had arrived at a similar conclusion in *The Art of Noises* (1916).

> And here it can be demonstrated that the much poeticised silences with which the country restores nerves shaken by city life are made up of an infinity of noises, and that these noises have their own timbres, their own rhythms, and a scale that is very delicately enharmonic in its pitches.[42]

Using sounds from the environment, the piece opens itself up to indeterminacy; noises "outside" the score are essentially unpredictable and also uncontrollable. In some ways, Cage had already achieved this idea in the previous year's *Imaginary Landscape No. 4* for 12 radios (1951), where "the huge amount of pre-packaged sounds we are confronted with daily are presented as a musical work".[43] Clearly, all the radio stations would be transmitting sounds from outside the score. But unlike the sounds of the environment, sound from a radio can be manipulated. Where Cage had used *I Ching* to determine duration in *4'33"*, in *Imaginary Landscape No. 4* it was used to control the wavelengths, durations and volumes of the radios. As a result, the piece required 24 players, two per radio (one for the volume control and one for the station dial).[44]

Cage went on to create many more duration pieces, but *4'33"* marked a turning point in his philosophy and its influence could be heard in many of his works thereafter in pieces like *MusiCircus* (1967) where performers are encouraged to behave independently, creating an indeterminate sound environment.[45] Ten years later he wrote *0'00"* (1962) – sometimes

[42] Ibid., para. 10.
[43] Landy, Leigh, "Duchamp: Dada Composer and his Vast Influence on Post-World War II Avant-garde Music", *Avant Garde, no. 2,* p. 140.
[44] Ibid.
[45] "The idea of this composition is nothing more than an invitation to a number of musicians, who perform simultaneously anything or in any way they desire. The manuscript is a list of musicians with various pieces of music by Cage and Satie and some non-musical works, also including a diagram for positions of various individuals." http://www.johncage.info/workscage/musicircus.html

called *4'33" No. 2.* This is very different to its namesake. The score, entirely verbal, is to be performed "in any way by anyone":

> In a situation provided with maximum amplification (no feedback), perform a disciplined action, with any interruptions, fulfilling in whole, or in part, an obligation to others. No two performances are to be of the same action, nor may any action be the performance of a 'musical composition'. No attention is to be given to the situation (electronic, musical, theatrical).[46]

Rather than referring to the duration of the piece, Cage chose the title *0'00"* to imply a music "that does not depend on time".[47] The aim of this was to bring down the boundaries between art and life and to express his belief that all sound was music, that restricting music to a timeframe was unnecessary if one could appreciate the unpredictable sounds of the environment, those that enveloped daily life. Under this condition, music exists without interruption, so that it is "nothing but the continuation of one's daily work...What the piece is trying to say is that everything we do is music, or can become music through the use of microphones [...]".[48]

2.2.1.3 Morton Feldman, Earle Brown and Christian Wolff

The discovery that Cage made with Zen attracted the attention of a number of other composers: Morton Feldman, Earle Brown and Christian Wolff. Sometimes associated with the New York Action School of painters, each developed an individual way of working with chance in the creation of unpredictable music, different to that of Cage. Wolff studied as Cage's pupil and his early pieces reflected a comparable interest in sound and simplicity (e.g., *Duo for Violins* (1950) has a pitch range of just three chromatic notes). *Duo II for Pianists* was entirely indeterminate and could last any length of time. In *Silence*,

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[46] Soloman, Larry, *The Sounds of Silence: John Cage and 4'33"*, para. 27.
[47] Ibid., para 29.
[48] Ibid.

Cage comments that this quality allows it to adjust to the "circumstances of the concert occasion" so that "where only five minutes are available, it will be five minutes long".[49]

In *Intersection I* (1951), Feldman also placed note choices in the hands of the performers. Scored for large orchestra, not a single pitch was defined. The piece contained only four parts: one for wind instruments, one for the brass instruments, one for violins and violas, and one for cellos and basses. Each part indicated three ranges of pitch (high, middle and low), the limits of which were to be determined by the performers. In doing so, the score provided all the information required to generate simple melodic shapes, although the piece was more an investigation of sound than of chance melodies. The score was also free of dynamic markings and fixed durations. By the 1960s, Feldman had established his own, distinct "soundworld" of quiet sounds. In contrast to Cage's desire for impersonal music, Feldman's later pieces were recognisably "Feldman".

Brown summarised the difference between his and Cage's work neatly, "I was doing the exact opposite of what John was doing. [...] I was interested in leaving the form open, and John was interested in leaving the content open!"[50] Brown's interest in open form was to combine with his interest in the visual arts. This led to the piece *December 1952* (1952), which contains no traditional notation whatsoever, but a series of vertical and horizontal lines of different lengths and widths scattered sparsely on a single white page. Looking nothing like a normal "dots and staffs" music score, it can be interpreted any number of ways. His inspiration came from Calder's mobiles, which could be viewed differently from all angles and yet maintain an identity. It represents a notation for a completely indeterminate music, an idea taken up by many others (e.g., Anestis Logothetis in *Agglomeration* (1960), Cornelius Cardew in *Treatise* (1963-67)).

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[49] Cage, John, *Silence: Lectures and Writing*, Calder and Boyars, London, 1973, p. 39.
[50] Hixon, J.D., "Earle Brown: No Beginnings, No Endings... and the Paradox of Art", Hixon interviews Brown, in Brown's sitting room, May 2002. http://studiofornewmusic.com/ebrowninterview.htm

2.2.2 Boulez and Serialism

Between 1949-54 (running parallel to the activities of Cage, Feldman, Brown and Wolff), the Darmstadt Summer School in Germany played a central role in the serial movement, with Messiaen's pupils – Boulez and Stockhausen – as its most prominent figures. The movement gained much of its stimulus from the pieces of Webern, who ultimately reduced the motif to its minimum requirement, two notes i.e., an interval. Inspired by this, the Darmstadt composers became increasingly concerned with the total organisation of musical materials by way of series, eventually achieving this for the first time with Boulez's *Structures 1a* (1951). The movement's activities concurred with developments taking place in electronic music and the ongoing search for a type of artistic expression that would represent a new beginning. New electronic instruments, such as oscillators, encouraged composers to start thinking about music parametrically. It was widely believed at this time that numerical approaches were the key to producing objective works of art. Serialism was said to offer,

> [...] in theory at least, a system of composition which obliged composers to think objectively and eliminate memory, so that the musical heritage of the past was blotted out and a completely new music created.[51]

This view was upheld by Joseph Schillinger, whose two publications, *The Schillinger System of Musical Composition* (1941-46, two volumes) and *The Mathematical Basis of the Arts* (1948), published after his death in 1943, embodied the first major theoretical works aimed at freeing artists from their "geographical and historical boundaries"[52] by way of mathematics. In comparison, Messiaen's *Technique de mon language musical* (1944) did not go as far, but succeeded in establishing connections between music and numbers in his own work, providing the foundations for *Mode de valeurs et d'intensités* (1949).

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[51] Smith-Brindle, Reginald, The New Music: The Avant-Garde since 1945, 2nd edition, Oxford, University Press, Oxford, 1987, p. 23.
[52] Ibid., p. 22, citing Schillinger, Joseph, *The Mathematical Basis of the Arts*, New York, 1948.

Historically, *Mode de valeurs* signifies the start of a chain of events surrounding Darmstadt. The piece comprises a three-part counterpoint, each with a different set of twelve chromatic pitches and twelve chromatic durations.[53] Each of the 36 pitches is permanently assigned one of 36 durations, one of seven modes of attack and one of seven dynamics. The construction of the piece, however, is not serial. Instead, notes are ordered freely (in what could be described as a quasirandom manner because of its unpredictability) so as to avoid creating any recognisable tonality.[54] The end result prompted Stockhausen to describe it as a "fantastic music of the stars",[55] a suitable description for a piece of music built from points of sounds of different magnitudes. It also inspired him to pursue "pointillist" writing, in the piece *Punkte* (1952).

Controlling musical parameters by way of series signalled the beginning of musical automation. It is certainly true that Webern had made important steps towards total organisation a number of years earlier, but his works had only received the attention of a few scholars at this time. Cage may have also had an influence on the movement. Griffiths suggests that an analysis of Webern's *Piano Variations* (1935-36) by Karel Goeyvaerts, published 1949-50, may have motivated Messiaen to write *Mode de valeurs*.[56] He also puts forward a somewhat controversial theory that it was Cage who identified the basic parameters of music, which later provided the organisational approach of total serialism. In his essay "Forerunners of Modern Music", first published in March 1949 (and later in *Silence* in 1961) Cage writes, "Sound has four characteristics: pitch, timbre, loudness, and duration".[57] Boulez echoed this sentiment in his introductory speech at a soirée held in Paris in June 1949 (which Cage attended) when he referred to "duration, amplitude, frequency and timbre – in other words, the four characteristics of a sound".[58]

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[53] Chromatic durations: a scale of duration formed by an arithmetic process, built around a basic unit of duration. The scale may range from one times the unit of duration to 12 times the unit of duration.
[54] Griffiths, Paul, *Modern Music and After: Directions Since 1945*, Oxford University Press, Oxford, 2002, p. 30.
[55] Ibid., p. 31, citing Wörner, K.H., *Stockhausen: Life and Work*, London, 1973, p. 61.
[56] Ibid., pp. 31-32.
[57] Cage, John, *Silence: Lectures and Writing*, Calder and Boyars, London, 1973, p. 63.
[58] Griffiths, Paul, *Modern Music and After: Directions Since 1945*, Oxford University Press, Oxford, 2002, p. 29.

2.2.2.1 Total Serialism: Non-equivalence and Automation

Boulez was impressed by Cage's use of square number charts[59] and adopted them in *Structures 1a,* but whereas Cage found in them a way of removing his own control and attaining non-intention, Boulez used them to aid total serial organisation. In *Structures 1a* he used two twelve-by-twelve charts or matrices from which forty-eight forms of the series were extracted (see Chapter 4 for more detail). With these matrices, Boulez controlled the parameters of the piece; unlike *Mode de Valeurs,* the durations were not fixed to specific pitches.

> I wanted to use the potential of a given material to find out how far automatism in musical relationships would go, with individual invention appearing only in some very simple forms of disposition.[60]

In particular, one aspect of *Structures 1a* remained down to "individual invention": its form. Boulez arranged this according to his own tastes rather than from the series. In terms of automation, this was an unsatisfactory solution, stemming from the lack of equivalence between the tempered scale (the basis of the series) and the majority of other musical parameters. One of the biggest challenges serialists faced was the non-equivalence of sound itself. In *Structures 1a,* Boulez placed a degree of control over timbre with a scale of ten modes of attack ranging from gentle to intense. This may have been considered adequate for a piano, but as Griffiths writes:

> There was no obvious way in which one might place in order, for example, the sound qualities of harp, cello, flute, and horn.[61]

In *Studie I* (1953), Stockhausen attempted a solution based on the reversal of the theory that all complex sounds could be analysed as a collection of sine waves.[62] Abandoning the twelve tones of the tempered scale, each timbre was constructed from six sine wave

[59] Ibid., p. 24.
[60] Ibid., p. 38.
[61] Ibid., p. 44.
[62] This comes from the work of Helmholtz and Fourier.

frequencies, the ratios of which were used to derive the entire series, controlling rhythm as well as the parameters of sound.

Non-equivalence was a problem affecting rhythm too. In *Structures 1a*, Boulez used the system of chromatic durations created by Messiaen, but in the paper "Possibly..." (1951) he indicated his dissatisfaction with this procedure. Here, Boulez attempted to forge a complex relationship between pitch and rhythm whereby "one could define twelve durations which reproduced the frequency ratios of the chromatic scale so that when the tempo is changed, durations are transposed", but this again was arbitrary, since there was no actual connection between pitch and changes in tempo. In America, Milton Babbitt was developing his own serial techniques, which went some way to resolve the non-equivalence problem existing between rhythm and pitch. Whereas Boulez and Stockhausen continued for the most part to use systems based on chromatic durations, Babbitt recognised that pitch had its own unit of repetition, the octave, for which a rhythmical equivalent could be found.[63]

For Boulez, total serialism brought with it too many restrictions and a wariness of automation; his reluctance to forgo the role of the composer resulted in a dualism between the impersonal process of automation and his own free will as a composer.[64] For Cage though, fully automated composition systems were no bad thing since they meant another step on the path to non-intention.

2.2.2.2 Open Form

Brown's exploration of open form was not the first. One of the earliest examples of open work music was *Mosaic Quartet* (1934) by Henry Cowell; its sections could be performed

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[63] Griffiths, Paul, *Modern Music: A Concise History*, Thames and Hudson, 1996, p. 137.
[64] Griffiths, Paul, *Modern Music and After: Directions Since 1945*, Oxford University Press, Oxford, 2002, p. 39.

in any order and also repeated. Having said that, Brown's graphic approach to *December 1952* was a milestone. Open form is also associated with the fallout between Boulez and Cage. In a letter to Cage, Boulez expressed his feelings regarding the use of chance, "the thought of it is unbearable!"[65] He continued his criticisms more publicly in the article "Alea", where (mentioning no names) he stated: "The most elementary form of chance transformation goes along with a philosophy tinged with orientalism, which covers up a basic weakness of compositional technique... This experimenting with chance I term carelessness". Thus, when Boulez took up the use of open form in the *Third Piano Sonata* (1955-57), supposedly inspired by the poet Mallarmé, Cage was not greatly impressed:

> After having repeatedly claimed that one could not do what I set out to do, Boulez discovered that Mallarmé *Livre*. It was a chance operation down to the last detail. With me the principle had to be rejected outright; with Mallarmé it suddenly became acceptable to him. Now Boulez was promoting chance, only it had to be *his* kind of chance.[66]

Indeed, Boulez's approach was not altogether the same. Where Cage rejected the role of the composer in preference of a transferral of responsibility to the performer, Boulez chose a method of "directed chance",[67] "a sort of labyrinth with several paths".[68] In Mallarmé's imaginary book he discovered a similar maze-like quality to those he had enjoyed in Joyce's *Finnegans Wake*:

> It must be our concern in the future to follow the examples of Joyce and Mallarmé and to jettison the concept of a work as a simple journey starting with a departure and ending with an arrival. [...] As against this classical procedure the idea of a maze seems to me the most important recent innovation in the creative sphere.[69]

Griffiths states that it was apparently after the first draft of the *Third Piano Sonata* that:

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[65] Nattiez, Jean-Jacques, *The Boulez-Cage Correspondence*, Cambridge University Press, Cambridge, 1999, p. 18.
[66] Ibid., p. 19.
[67] Ibid., citing Boulez, Pierre, *Stocktakings from an Apprenticeship*, Seuil, Paris, 1966, p. 31.
[68] Ibid., citing *Stocktakings...*, p. 29.
[69] Boulez, Pierre, *Orientations: Collected Writings*, ed. J.-J. Nattiez, trans. Martin Cooper, Harvard University Press, Cambridge, 1986, pp. 144-145.

> Boulez came to know of Mallarmé's dream of a Book that would be endlessly mutable, a Book whose segments could be chosen and ordered at will for public readings. Learning of this could only have intensified his feelings of proximity to a poet who had overturned existing grammar [...].[70]

In the *Third Piano Sonata* Boulez's instructions ask the performer to prepare a route through the various options of the piece, prior to playing it. Only two of its five movements have been published (*Trope* and *Constellation-Miroir*); it was intended that they be performed in any order, with the exception of the third, which was to remain central, creating a sense of symmetry. *Trope* was a ring-bound folder containing four items to be played in various orders, whereas *Constellation-Miroir,* inspired by the appearance of Mallarmé's poem *Un coup de dés jamais n'abolira le hasard* (*One throw of the dice will never abolish chance,* 1897), consisted of a number of large sheets of paper upon which were scattered melodic fragments organised in such a way as to "defy compulsion". This was very much in keeping with Mallarmé's poem (see *figure 2-3*), which presented the reader with a book of interchangeable pages of text, where the shapes formed by groups of words, and use of different sized fonts, results in an open-ended experience.[71]

A collection of Mallarmé's poems provided the libretto for Boulez's much-revised *Pli selon pli* (1957-89), consisting of five sections: *Don, Improvisation sur Mallarmé I, Improvisation sur Mallarmé II, Improvisation sur Mallarmé III,* and *Tombeau.* Initially, *Improvisation sur Mallarmé III* offered the performers much freedom with its material but Boulez's revisions made this less of a feature. *Improvisation sur Mallarmé II* restricted the freedom to tempo variations controlled by the conductor (in most cases, Boulez himself).

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[70] Griffiths, Paul, *Modern Music and After: Directions Since 1945*, Oxford University Press, Oxford, 2002, p. 108.

[71] Parallels can be made between Mallarmé and Guillaume Apollinaire, who believed that language was something to be experienced for its concrete and graphic shapes, for its potential to convey meanings in other ways and, in a material sense, its existence as visual marks of white on black or as patterns of sound. His sound poetry illustrates this; to convey more than the meanings of the words themselves, they are written on paper in swirly typography, drawing comparisons with graphic scores developed over the following decades to encourage indeterminacy in musical performance.

C'ÉTAIT *LE NOMBRE*

issu stellaire

EXISTÂT-IL

autrement qu'hallucination éparse d'agonie

COMMANÇÂT-IL ET CESSÂT-IL

sourdant que nié et clos quand apparu

enfin

par quelque profusion répandue en rareté

SE CHIFFRÂT-IL

évidence de la somme pour peu qu'une

ILLUMINÂT-IL

CE SERAIT

pire

non

davantage ni moins

indifféremment mais autant

LE HASARD

Choit
la plume
rythmique suspens du sinistre
s'ensevelir
aux écumes originelles
naguères d'où sursauta son délire jusqu'à une cime
flétrie
par la neutralité identique du gouffre

Figure 2-3: Extract from Un coup de dés jamais n'abolira le hazard *by Mallarmé*[72]

With Boulez and Cage at odds with each other over the use of chance, it was around this time that Stockhausen also began to experiment with chance. He settled for a more central position, as displayed in *Klavierstück XI* (1956). The piece contained nineteen groups, varying in length from very short to quite long, on a single, large piece of paper. Groups could be picked according to where the performers' eyes landed on the page. At the end of each group the tempo, dynamic level and attack for the next group were indicated.

[72] http://www.poetes.com/mallarme/coup_de.htm

Stockhausen compared it to a Markov Chain, "a series of mutually dependent symbols".[73] When groups were chosen a second time, octave transpositions were used; the third time a group was chosen, a version of the piece would come to an end. Boulez and Cage both criticised the use of chance in the piece, but for opposite reasons. Cage argued that it was "unnecessary" since it was "ineffective" in breaking from the Western tradition; "The work might as well have been written in all its aspects determinately".[74] Boulez contended that it let in an element of chance that was "inimical to the integrity of the work".[75]

2.2.3 Stochastic Music

After World War II, during which he had fought against the Germans in Greece, Xenakis moved to Paris and began working for the French architect, Le Corbusier. The discovery of new forms of architecture had a noticeable effect on his music: "[...] instead of boring myself with mere calculations, I discovered points of common interest with music, which remained, in spite of all, my sole aim".[76] In short, he was able to visualise music through the shapes found within his architectural drawings. Le Corbusier suggested Xenakis meet with Messiaen, who encouraged him to pursue his individual approach to composition. It was an endorsement that led to Xenakis's first mature pieces, *Metastasis* and *Pithoprakta*, both characterised by their use of probability theory to control "sound masses". At a time when experimental composers seemed to be faced with the option of either chance or serialism, Xenakis drew upon his knowledge of architecture and advanced mathematics and offered a new direction with what he called "stochastic music".

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[73] Ibid., p. 104. These are "sequences of random variables in which the future variable is determined by the present variable but is independent of the way in which the present state arose from its predecessor". http://www-groups.dcs.st-and.ac.uk/~history/Mathematicians/Markov.html
[74] Cage, John, *Silence: Lectures and Writing,* Calder and Boyars, London, 1973. p. 36.
[75] Griffiths, Paul, *Modern Music and After: Directions Since 1945,* Oxford University Press, Oxford, 2002, p. 105.
[76] Zografos, Markos, "Iannis Xenakis: The Aesthetics of his Early Works", http://www.furious.com/perfect/xenakis.html

Analogous to Varèse, whose use of sirens and rumbling bass drums were a sonic reminder of World War I, Xenakis was keen to explore the sonic properties of "sound masses" such as the mass street protests he had experienced whilst serving in the Communist resistance. In *Formalized Music*[77] (first published in 1971) he set out his theory:

> Everyone has observed the sonic phenomena of a political crowd of dozens or hundreds of thousands of people. The human river shouts a slogan in a uniform rhythm. Then another slogan springs from the head of the demonstration; it spreads towards the tail, replacing the first. A wave of transition thus passes from the head to the tail. The clamor fills the city, and the inhibiting force of voice and rhythm reaches a climax. It is an event of great power and beauty in its ferocity. Then the impact between the demonstrators and the enemy occurs. The perfect rhythm of the last slogan breaks up in a huge cluster of chaotic shouts, which also spreads to the tail. Imagine, in addition, the reports of dozens of machine guns and the whistle of bullets adding their punctuations to this total disorder. The statistical laws of these events, separated from their political or moral context, are the same as those of cicadas or even the rain. They are the laws of the passage from complete order to total disorder in a continuous or explosive manner. They are stochastic laws.[78]

From the above description, it is evident that Xenakis's concept of sound was deeply affected by the violent sounds of war, and it was possibly this that made Cage's idea of elevating everyday sounds to the status of art seem so unappealing. He once commented that he found the sounds of the environment, which Cage encouraged everyone listen to, "completely banal and boring", adding "I'm not interested in reproducing banalities".[79] This was accompanied by a rejection of Cage's use of chance as "an abuse of language and [...] an abrogation of a composer's function".[80] Xenakis also attacked serial approaches to music, at a time when European composers were still exploring its potential. In his essay, "The Crisis of Serial Music" from 1954, Xenakis states:

[77] The title implies music based on a rules-based approach.
[78] Xenakis, Iannis, *Formalized Music: Thought through Mathematics in Music*, Pendragon Press, Stuyvesant NY, 1992, p. 9.
[79] Zografos, Markos, "Iannis Xenakis: The Aesthetics of his Early Works", *Perfect Sound Forever*, 2004, citing Khai-Wei Choog, Iannis Xenakis and Elliot Carter: A Detailed Explanation and Comparative Study of Their Early Output and Creativity, Griffith University, Brisbane, 1996, p. 32.
[80] Ibid., citing Bois, Mario, *Iannis Xenakis: The Man and his Music: A Conversation with the Composer and a Description of his Works*, Greenwood Press, Westport, 1980, p. 12.

> Linear polyphony destroys itself by its very complexity; what one hears is in reality nothing but a mass of notes in various registers.[81]

Griffiths points out that it was exactly this quality that caused Stockhausen to refer to *Mode de valeurs* as the music of the stars.[82] He concludes that Xenakis's criticisms were more likely aimed at his contemporaries' abandonment of "traditional linear consequence", and the rationalization of music in terms of grammar and serial order rather than the way the music sounded.[83]

> If the effect was to be 'nothing but a mass of notes', the means to produce that effect should be sought in the branch of mathematics that had been developed to deal with such statistical phenomena.[84]

Upon this conclusion, he set out to explore the properties of sound masses, determining their shape, but allowing the details to be formed according to probability laws.

> With a large quantity of isolated sounds spread across the whole sound spectrum, a dense "granular effect" emerges, a real cloud of moving sound material, governed by the laws of large numbers.[85]

He applied this to the morphology of sound, transformations from "discontinuous" to "continuous" that could be controlled with probability theory. In music, continuous sounds can be made from discontinuous and continuous sounds, "a multitude of short glissandi on strings can give the impression of continuity, and so can a multitude of pizzicati".[86]

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[81] Xenakis, Iannis, *Formalized Music: Thought through Mathematics in Music*, Pendragon Press, Stuyvesant NY, 1992, p. 8.
[82] Griffiths, Paul, *Modern Music and After: Directions Since 1945*, Oxford University Press, Oxford, 2002, p. 91.
[83] Ibid.
[84] Ibid.
[85] Taken from the CD booklet for *Xenakis: Metastasis, Pithoprakta, Eonta*, 2001.
[86] Xenakis, Iannis, *Formalized Music: Thought through Mathematics in Music*, Pendragon Press, Stuyvesant NY, 1992, p. 9.

2.2.3.1 *Metastasis* and *Pithoprakta*

Probability theory provided Xenakis with a theoretical base for *Metastasis* and *Pithoprakta,* where the overall sound contours were determined (i.e., probabilities of the inner details were worked out before hand). A possible connection to quasiorder has already been established at the start of section 2.2. *Metastasis* (scored for forty-six strings, seven brass, six winds and two percussion, each with a separate part) can be divided into three sections. In this piece, and others to follow, Xenakis conceived music as a "field of sound", within which notes could be plotted as vectors over multidimensional axes including those of duration, frequency and dynamic.

The first and third sections make up the "mass sections" where the orchestra plays *divisi,* e.g., during the opening bars the strings each play different parts of equal importance to the whole. These sections may be characterised as "nonfigurative" and "athematic",[87] with the emphasis placed on timbre. Whilst the stringed instruments perform both pizzicato and "glissandi in avalanches", the brass section is heard in "total disorder".[88] By contrast, the middle section of the piece involves fewer instruments in chamber music based on a melodic theme derived from a partial row (although not by way of serial techniques).

To calculate the movements of the details Xenakis applied Boltzmann's Kinetic Theory of Gases. This states that the temperature of a gas can be understood to be "the mean velocity of it composite molecules".[89] Xenakis drew an analogy between a molecule of gas moving through space and the pitch of a string instrument through its pitch range. To create movement he controlled the "molecules" according to a sequence of imaginary temperatures and pressures, which in turn supplied the shape of the music. The angles of each *glissandi* (on a distance/time graph this would indicate a molecule's velocity) were calculated individually, whereas the musical materials (intervallic structure, and the

[87] Matossian, Nouritza, *Xenakis*, Kahn and Averill, London, 1986, p. 60.
[88] Ibid.
[89] Oda, Tako, *Iannis Xenakis and John Cage: Two Sides of a Tossed Coin*, 1998. http://people.mills.edu/toda/chance/MainBody.html

duration of notes and dynamics) were acquired using a different process, based on the Fibonacci series.[90] The results were plotted on graph paper with pitch along the y-axis and time along the x-axis. The opening section is famously associated with Xenakis's design for the architecture of the Philips Pavilion at the 1958 Brussels Exposition (see *figure 2-4*). When plotted graphically, it is possible to see how the sweeping *glissandi* form similar curves. These *glissandi* can hardly be described as sounding random, yet their movements are governed by probability.

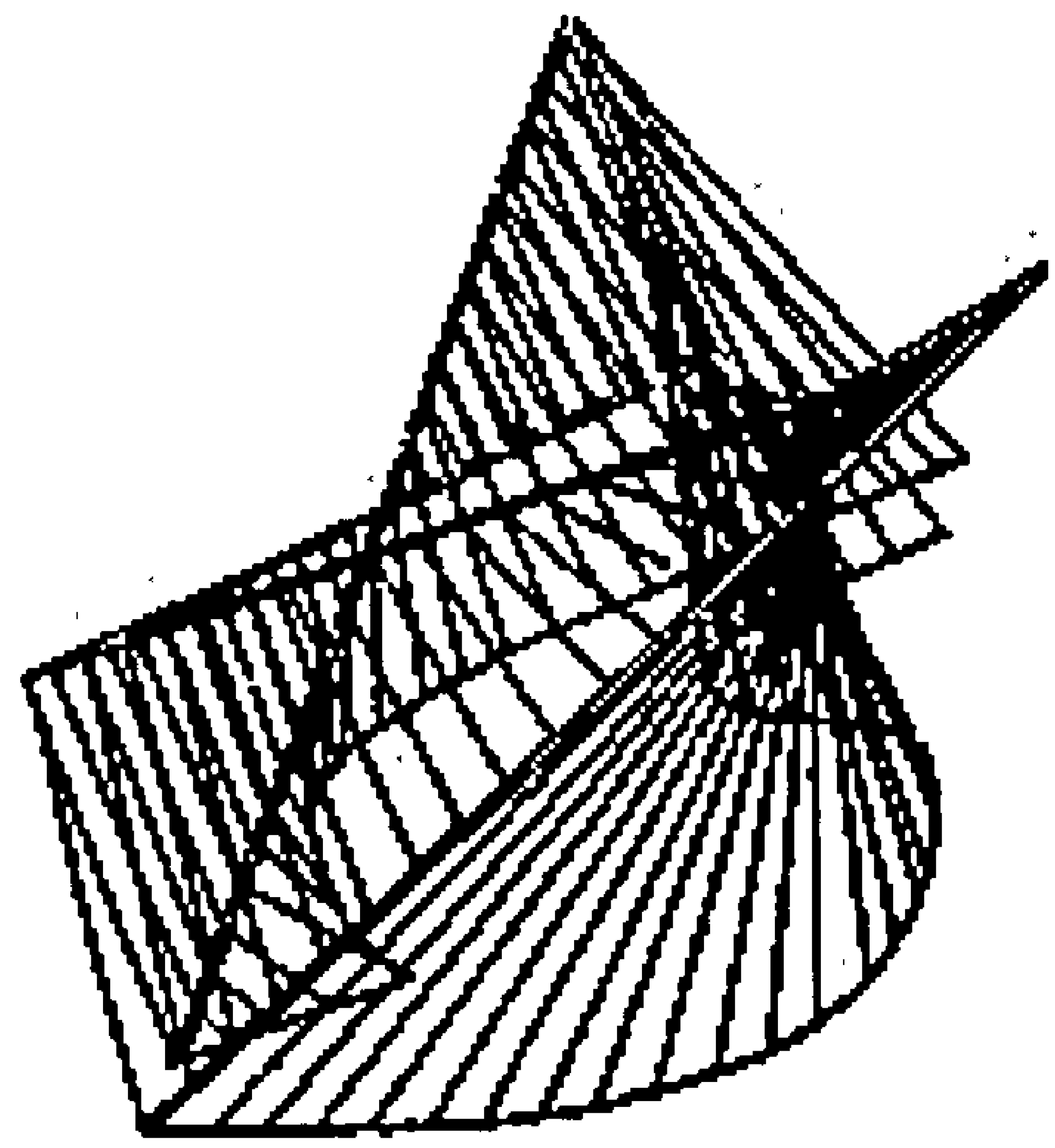

Figure 2-4:Xenakis's model of the Philips Pavilion

By comparison, *Pithoprakta* was composed entirely from probability theory.[91] In bars 52 to 60 (see *figure 2-5*), he combined the Kinetic Theory of Gases with Bernoulli's Law of Large Numbers, which states that as the number of occurrences of a chance event increases, the more the average outcome approaches a determinate end (the more you flip a coin, the closer the average outcome is 0.5 heads/0.5 tails).

[90] In this series, created by Leonardo Fibonacci in 1202, each number is the sum of the previous two, i.e., (0), 1, 1, 2, 3, 5, 8, 13, 21, 34 and so on. As the series continues the ratios between consecutive numbers, get closer and closer to the golden ratio numbers: 0·6180339887... or 1·6180339887... It could therefore be said to mirror the entropy of the stochastic laws. In architecture it can be used to determine the proportions of buildings; in *Metastasis* it affects both small and large-scale proportions.
[91] Translated, the title means "action through probabilities" and it demonstrated even more dramatically the idea of sound morphology.

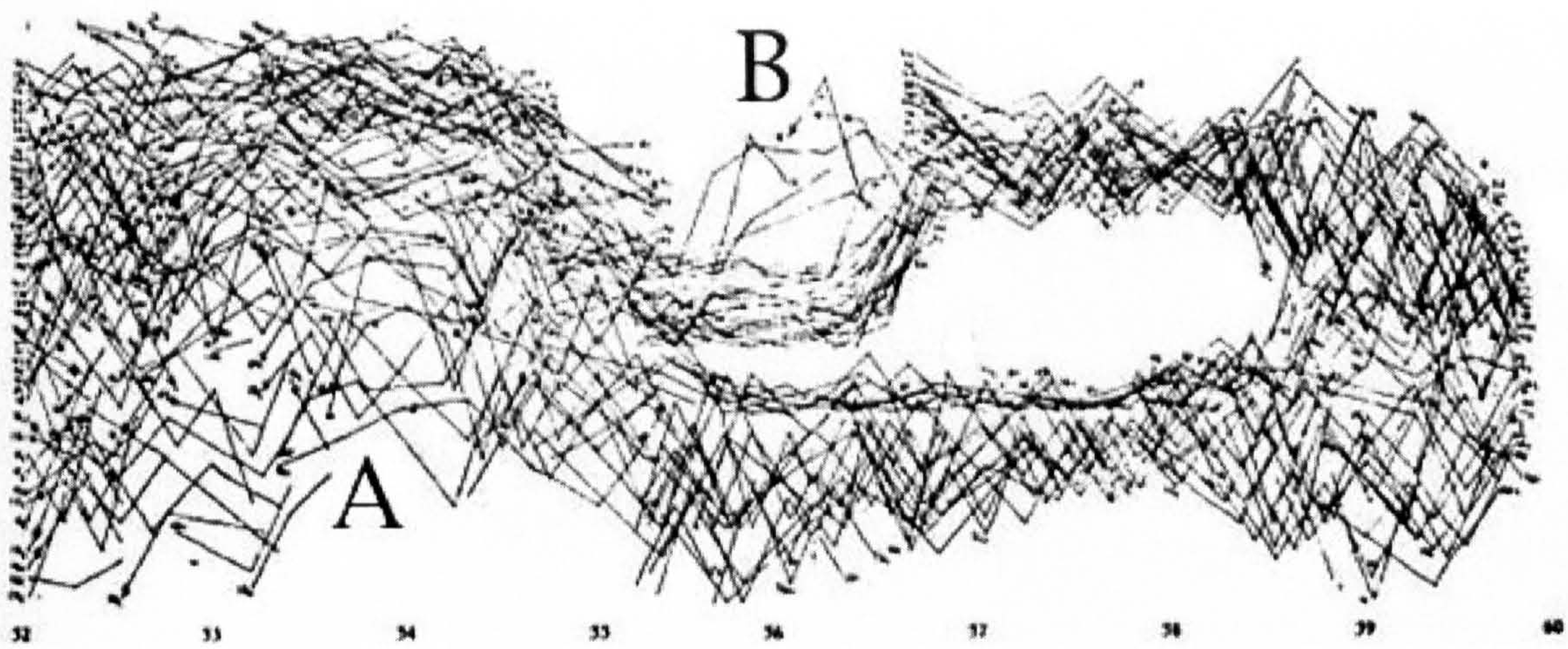

Figure 2-5: Section from Pithoprakta *(bars 52-60)*[92]

Oda states that in these bars, Xenakis "represents a snapshot of a large number of discrete molecular velocities in a body of air standing at a constant temperature".[93] By hand, Xenakis calculated 1,148 velocities. Were these to accurately represent a "snapshot" of the movements of molecules in a gas, they would have to occur simultaneously, but Xenakis plotted them on graph paper using 46 stringed instruments to play an average of 25 notes (i.e., 46x25=1150).

In this extract, the *x*-axis represents time; the *y*-axis represents a pitch range of five octaves (60 notes), which he divided into 15 smaller note ranges, each spanning four chromatic notes. The straight lines represent the course of the *glissandi*, with the angle of each slope proportional to the molecular velocities generated by the Kinetic Theory of Gases. In *figure 2-5* it can clearly be seen that glissandi occur in both upward and downward directions, some even falling outside the general trend of things (e.g., points A and B). Oda highlights that:

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[92] Zografos, Markos, "Iannis Xenakis: The Aesthetics of his Early Works", *Perfect Sound Forever*, 2004 citing drawing found in the book Matossian, Nouritza, *Xenakis*, Kahn & Averill, London, 1986, p. 98.
[93] Oda, Tako, "Iannis Xenakis and John Cage: Two Sides of a Tossed Coin". http://people.mills.edu/toda/chance/frames.html

> With his strong background in mathematics and science, Xenakis knew the *Law of Large Numbers* was meaningless unless the collective events occurred simultaneously. He also understood that 46 outcomes could not possibly have qualified as a statistically large sample. Yet somehow, the 1,148 events were meant to be taken in simultaneity, despite the 18.5 seconds necessary for execution.[94]

Figure 2-5 shows how the random details can be perceived to form shapes, e.g., the undulating contours along the outside and the hole that appears in the middle. These are quasiorder shapes made out of randomness perceived as order.

In both *Metastasis* and *Pithoprakta*, Xenakis wrote out the calculations by hand and transferred them to manuscript paper. In later pieces, e.g., *Eonta* for piano and brass quintet (1963-4), such calculations were facilitated by the use of a computer.[95] Xenakis was able to fuel the programs with random seed values to create automated pieces such as *Achorripsis* (1956-57), which incorporated Markov chains.

2.2.4 Summary

This section has provided an overview of the issues which predominated in twentieth century avant-garde music throughout the 1950s. It has been argued that uses of randomness, quasirandomness and (to an extent) quasiorder are identifiable in specific works of this period by Cage, Boulez and Xenakis, respectively. Whether or not to give up control and leave decisions usually made by the artist to chance has caused a division in the arts as prominent in the works of Dadaists like Tzara and Arp as it is in the philosophical approaches to music explored by Cage and Boulez. On the other hand, Xenakis took the view that, rather than seeing randomness or quasirandomness as an end in itself, it could be

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[94] Ibid.

[95] Xenakis was not the first to facilitate the process of composition with computers. The *Illiac Suite* (1957) by Lejaren Hiller was completed a number of years before Xenakis used a computer to compose. In this computers were used to make creative decisions; computer algorithms were employed to model traditional, non-algorithmic compositional procedures (e.g., Baroque 4-part harmony, serialism).

applied in such a way as to bypass such debates entirely, e.g., by using a branch of mathematics developed to deal with large amounts of data.

The following section highlights some of the uses of randomness in popular music from over the past forty years. Unlike the music discussed so far in this chapter, it is in the nature of popular music to be almost entirely predictable (a matter discussed in more detail in Chapter 5), so that for it to include randomness is relatively uncommon. With this in mind, it is may be less surprising how influential composers such as Cage were on the counter-cultural rock groups of the 1960s, who rejected the demands of mass market. This section also provides an historical context for Chapter 3.

2.3 UNPREDICTABILITY IN POPULAR MUSIC

Music scholarship offers little indication of how unpredictability has contributed to popular music. Even methodical popular music surveys like those conducted by Simon Frith and Richard Middleton give away few clues, concentrating, as they do, on more commercial areas of popular music. True, unpredictability is associated with experimentalism (Cage), and this has never been a central component of chart-orientated music, but it has played a role in the more openly progressive genres. For the most part, then, it would seem that one of the most interesting stories of 20th century music, the impact of 1950s experimental music on popular music, has been neglected.

To put this into context, consider Frank Zappa, who features prominently in the next chapter of this thesis. His body of work incorporates some of the most wide-ranging uses of unpredictability in popular music and provides an indication as to just how avant-garde popular music can be. Nonetheless, this is something rarely celebrated by the popular music industry. It is telling that on the tenth anniversary of his death in December 2003, there was more media coverage on BBC Radio 3 than on BBC Radio 1.

Since most general histories of popular music display a tendency to skip over experimentation, it is necessary to look elsewhere. In *Rationalizing Culture: Ircam, Boulez, and the Institutionalization of the Musical Avant-Garde* (1995), Georgina Born argues that avant-garde rock is a postmodern development that may be viewed alongside pop-influenced art music. Both reference "taboo aesthetic devices from the other side of contemporary music" and "create a provocative tension by remaining firmly grounded in their respective institutional bases (commercial popular music, subsidised high culture)".[96]

Another scholar who has tackled the issue of experimentation in popular music is Bill Martin. Martin aligns Cage's theories of chance in music, of surrendering intention, with the changes in attitude towards mastering one's instrument that took place in popular music towards the end of the 1960s. At the heart of his argument is a consideration of the marriage between ability, technique and originality. Martin asserts that in the late 1960s:

> Forms of experimentation that were seen as the domain of iconoclasts were taken up broadly. [...] In avant-garde art before rock music, a tension developed that was to be given full play in post-sixties rock, a tension between an emphasis on "technique" and a certain refusal of technique. [...] In many of the experiments of Dada, surrealism, abstract expressionism, and music that used randomising procedures, technical ability with paintbrushes or musical instruments was not very much in the foreground.[97]

Martin is arguing that since the 1960s, a dichotomy between technique and non-technique has structured how rock musicians approach experimentation,[98] the same dichotomy that emerged in avant-garde music in the 1950s. The main iconoclast in question, it turns out, is John Cage. Martin states that with Cage "it could even be said that the idea was more important than the execution"; such was the nature of his music that "technique was something that had to be broken through so that certain possibilities of music could be

[96] Born, Georgina, *Rationalizing Culture: Ircam, Boulez, and the Institutionalization of the Musical Avant-Garde*, University of California Press, 1995, p. 21.
[97] Martin, Bill, *Avant Rock: Experimental Music from the Beatles to Bjork*, Open Court Publishing Company, 2002, p. 3.
[98] Ibid., p. 4.

realised".[99] A musician's technique is often considered a mark of his or her musical personality, which is exactly what Cage objected to. By contrast, according to Martin, jazz musicians like John Coltrane and Cecil Taylor are inseparable from their technique.[100] The strength of their unique musical personalities is what attracts people to listen to them. Coltrane (technique) comes from a desire to "say" something, whereas Cage (refusal of technique) comes from a desire to "say" nothing. Martin then makes the important point:

> The virtuosos and near-virtuosos of progressive rock sometimes demonstrated, however that having a very large musical vocabulary did not necessarily mean that one had something to say.[101]

Progressive rock became big business during the early 1970s, with bands spending months in recording studios perfecting their albums, at great cost.[102] Punks responded by producing "warts and all" recordings on a shoestring budget. What they lacked in technique was made up for by the immediacy of the music. Mistakes (sounds made unintentionally and therefore fitting part of Cage's aesthetic) became part of their assault on the increasingly complex musical grammar expressed by progressive rock bands. As a result, punk studio recordings often maintained a live sound and a directness missing from progressive rock.

The negation of technique undeniably resulted in some forms of unpredictability in popular music but not all. For a number of musicians and composers in the 1960s, chance offered new ways of making music, of adding unpredictability to live performances and recordings, without any such sacrifice needing to be made.

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[99] Ibid., p. 3.
[100] Ibid., p. 3.
[101] Ibid., p. 4.
[102] Young, Charles, "Emerson, Lake and Palmer go for broke", Rolling Stone, 14 July, 1977. http://valseven.tripod.com/RS.html
In addition to the costs of the making records, prog groups were also fairly decadent when it came to touring. On 14 July, 1977, Rolling Stone reported that Emerson, Lake and Palmer had gone on tour with a "full symphony orchestra (57 instruments, six-person choir and conductor - rounded off by press-release arithmetic to 70 pieces), plus an entourage of 60 roadies, truck drivers, etc., at a weekly cost of $215,000".

In the wider scheme of things, chance was just another avant-garde technique that was finding an audience through its assimilation with popular music. This is exemplified nowhere more clearly than in Zappa's music of this period which contained musical references ranging across Varèse, Stravinsky, Webern and Cage, as well as popular music. Zappa was also inspired by the Dadaists and developed his own form of music theatre which relied on the spontaneity and unpredictable behaviour of his band members and audiences alike. These are examined in depth in Chapter 3; for comparative purposes, the following sections highlight methods of creating unpredictability employed by other well-known popular music artists.

2.3.1 The Beatles

Although they were not exponents of much unpredictability themselves, The Beatles did show an interest in it. Paul McCartney is known to have attended a concert by the free improvisation group AMM in the mid 1960s.[103] When The Beatles began to experiment in the recording studio, they were at the height of their fame and their ability to shape popular culture was significant. John Lennon and Paul McCartney's forays into experimentalism and avant-gardism were undoubtedly seen by others in the popular music industry as permission to break from learnt formulas and develop new forms of creative expression: experimentation became a trend with its own drug of choice. Edwin Pouncey comments:

> The fragmentation that was made concrete in the work of composers like Luciano Berio and Pierre Henry discovered a likeness, if a not wholly accurate reflection, in the distorting-mirror music of the LSD generation.[104]

He continues to point out that in just three years from their appearance on the Ed Sullivan Show in 1963, the innocent, "moptop" Beatles look had "given way to a hairier, acid-

[103] This was revealed to the author in an interview with AMM's drummer Eddie Prévost in 1998.
[104] Pouncey, Edwin, "Fables of the Deconstruction", *The Wire*, Issue 185, 1999. http://www.phinnweb.com/history/articles/concrete_rock.html

burned recalcitrance".[105] In the songs "Lucy in the Sky with Diamonds" from *Sgt. Peppers Lonely Hearts Club Band* (1967), "Strawberry Fields Forever" and "I am the Walrus" from *Magical Mystery Tour* (1967), John Lennon and Paul McCartney spliced sounds from various sources to try and capture musically the effects of taking LSD.[106] This area of experimentation culminated in the musique concrète piece "Revolution No. 9" from the *White Album* (1968).

> Many of the groups who subsequently fed found sounds into their songs were blissfully unaware of such musique concrète pioneers as Pierre Schaeffer [...]. They were merely following The Beatles' example by adding the appropriate "psychedelic" effects to an otherwise standard pop song.[107]

The track "A Day in the Life"[108] offers one of the more unpredictable listening experiences in The Beatles repertoire. The track was constructed by merging together two song fragments (the first by Lennon, the second by McCartney). These were linked by an orchestral crescendo arranged by George Martin, the occurrence of which still comes as some surprise. Martin's arrangement encouraged indeterminacy since it instructed the orchestral players to improvise within a defined framework:

> What I did there was to write, at the beginning of the twenty-four bars, the lowest possible note for each of the instruments in the orchestra. At the end of the twenty-four bars, I wrote the highest note each instrument could reach that was near a chord of E major. Then I put a squiggly line right through the twenty-four bars, with reference points to tell them roughly what note they should have reached during each bar.[109]

The crescendo occurs at two points during "A Day in the Life". To emphasis the effect further, four different takes were overdubbed to give the illusion that a 160-piece orchestra had performed it.

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[105] Ibid.
[106] Ibid.
[107] Ibid.
[108] The Beatles, "A Day in the Life", *Sgt. Peppers Lonely Hearts Club Band,* 1967.
[109] George Martin cited by Wikipedia. http://en.wikipedia.org/wiki/A_Day_in_the_Life

After The Beatles disbanded in 1970, Lennon's interest in experimentation continued with his release of *Plastic Ono Band* (1970), and he and Yoko Ono also appeared on stage with Frank Zappa and the Mothers of Invention as part of several improvised jams in 1971. Released by Lennon as *Some Time in New York City* (1972), he edited out the Mother's chanting "Now Yoko's in the scumbag, we're putting Yoko in the scumbag" and both he and Ono claimed writing credits for The Mother's tune "King Kong", much to Zappa's bewilderment.[110]

2.3.2 The Grateful Dead

Unlike other bands of the day, The Grateful Dead had a direct connection to the avant-garde. Behind much of the band's invention were Tom Constanten (keyboards) and Phil Lesh (bass), both composition students of Luciano Berio. Constanten had discovered the avant-garde composers Cage, Boulez and Stockhausen at an early age and was attracted by the way that their music was based on "thinking outside the box".[111] It would seem that The Grateful Dead were also attempting to think outside the box, but this time the box contained reality itself. LSD consumption may have contributed to the band's musical vision, but so too, the application of a musical education with its roots in the avant-garde.

> In the early sixties, Berio was in the midst of composing some of the most interesting works to come out of the European avant-garde. That's what attracted both Phil and me to his class, at Mills College, in early 1962. His classes mainly consisted – as did Stockhausen's, I later learned at Darmstadt – of discussions of matters of current interests to him. Things like orchestral blending and color, structural balance, the significance of gestures, phonology, even the very essence of meaning.[112]

The group produced a number of albums towards the end of the 1960s, amongst these their attempt to sonically re-create an acid trip from densely layered studio and live recordings, *Anthem of the Sun* (1968), and the live compilation *Live/Dead* (1969). On *Anthem*,

[110] Courrier, Kevin, *Dangerous Kitchen: The Subversive World of Zappa*, EWC Press, Toronto, 2002, p. 238.
[111] Interview with Tom Constanten from 2002.
http://www.digitalinterviews.com/digitalinterviews/views/constanten.shtml
[112] Ibid.

Constanten applied prepared piano to the track "That's It for The Other One", at one point letting off a gyroscope against the soundboard to produce a sound not unlike a chainsaw. *Live/Dead* featured their signature song, the largely instrumental, extended piece, "Dark Star". Fans recall how this twenty-minutes-plus piece was never performed the same way twice. Close listening to the *Live/Dead* version indicates that it consists of a number of interconnecting sections that smoothly flow into each other, with the order in which they occur established either prior to or during the song, e.g., by way of cues. The experience of listening to it is best compared to being an onlooker of a game the etiquette of which is unknown. The psychedelic effect of the music is enhanced by acid-inspired lyrics and Jerry Garcia's often disorientating improvised note choices. The Grateful Dead were very much a band best experienced live, each concert differing from the one preceding, suggesting that not only pieces but the shows themselves were open-form.

2.3.3 Brian Eno: *Oblique Strategies*

In the mid 1970s, Brian Eno, along with his friend, the painter Peter Schmidt, developed a deck of cards designed to "aid the creative process". Inspired by the *I Ching*, but more geared to artistic interpretations, and George Brecht's "Water Yam"[113], the *Oblique Strategies* combined the working principles of Eno and Schmidt – in particular, those resorted to during heavy workloads with approaching deadlines. The cards work by offering reminders of more productive ways of thinking that might otherwise be forgotten in stressful work situations.

> They can be used as a pack (a set of possibilities being continuously reviewed in the mind) or by drawing a single card from the shuffled pack when a dilemma occurs in a working

[113] Described by Eno as, "[...] A big box of cards of all different sizes and shapes, and each card had instructions for a piece on it. It was in the time of events and fluxes and happenings and all that. All of the cards had cryptic things on them, like one said, 'Egg event--at least one egg.' Another said, 'Two chairs. One umbrella. One chair' [...]". Bangs, Lester, "Brian Eno: A Sandbox In Alphaville", *Perfect Sound Forever,* Ben Catching III, 2003. http://www.furious.com/perfect/bangseno2.html

situation. In this case, the card is trusted even if its appropriateness is quite unclear. They are not final, as new ideas will present themselves, and others will become self-evident.[114]

> The first Oblique Strategy said "Honour thy error as a hidden intention". And, in fact, Peter's first Oblique Strategy - done quite independently and before either of us had become conscious that the other was doing that - was ...I think it was "Was it really a mistake?"[115]

Some *Oblique Strategies* leave interpretation open (e.g., "A line has two sides", "Water") or give specific instructions (e.g., "Use filters", "Abandon normal instruments").[116] Some are opposites of each other (e.g., either "Remove specifics and convert to ambiguities" or "Remove ambiguities and convert to specifics"), whilst others give advice (e.g., "Don't be frightened of clichés") or ask questions (e.g., "How would you have done it?"). Eno's role as an international producer frequently resulted in other groups using or coming into contact with the *Oblique Strategies*, e.g., Talking Heads on the album *Fear of Music* (1979).

> [...] With the Talking Heads I tried to embody those oblique strategies myself. I sat on the sideline and interfered exactly in that way. I supplied tangents which were chosen according to my taste or theirs. [...] I was very surprised at how their music could accommodate this kind of thing.[117]

In 1977, Eno collaborated with David Bowie on two albums, *Low* and *Heroes*, with *Oblique Strategies* utilised at varies stages on both. Eno remarked:

> On one of the pieces – "Sense of Doubt"[118] - we both pulled an Oblique Strategy at the beginning and kept them to ourselves. It was like a game. We took turns working on it; he'd do one overdub and I'd do the next, and he'd do the next. The idea was that each was to observe his Oblique Strategy as closely as he could. And as it turned out they were entirely opposed to one another. Effectively mine said "Try to make everything as similar as possible," which in effect is trying to create a homogeneous line, and his said "Emphasize differences" so whereas I was trying to smooth it out and make it into one continuum he was trying to do the opposite.[119]

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[114] Eno, Brian and Schmidt, Peter, *Oblique Strategies*, 1975.
http://www.rtqe.net/ObliqueStrategies/OSintro.html
[115] Ibid.
[116] *Oblique Strategies*. http://www.hitme.net/useful/oblique.html
[117] Mieses, Stanley, "Eno, before and after", from an unknown UK publication, c. 1978.
http://music.hyperreal.org/artists/brian_eno/interviews/unk-78a.html#producer
[118] David Bowie, "Sense of Doubt", *Heroes*, 1977.
[119] O'Brien, Glenn, "Eno at the edge of rock", Interview, Vol. VIII, No. 6, June 1978
http://music.hyperreal.org/artists/brian_eno/interviews/unk-78b.html

It is worth mentioning here that for a number of years prior to his involvement with Eno's *Oblique Strategies*, Bowie had been using a degree of chance in the preparation of lyrics. Throughout the early 1970s, he adopted the "cut-up" technique, made famous by William Burroughs, where a source of written material is cut up into individual words, sentences or fragments of sentences, and rearranged either by chance or in a quasirandom manner (the technique was later taken up (in varying degrees) by others in popular music, for example, Gary Newman, Throbbing Gristle and U2's Bono[120]). Bowie also kept a tape recorder by his bed to note down his dreams before he forgot them, tapping into subconscious patterns of thought that the conscious mind would have no control over as a consequence.[121]

2.3.4 Sonic Youth and Stereolab

Formed in New York in the mid 1980s, Sonic Youth began life as a post-punk noise band. In 1990, the mainstream label DGC signed them, placing them on a roster alongside grunge bands Mudhoney and Nirvana, with whom they toured the college circuit. By the end of the decade, the group had developed a reputation for art-rock releases, a point confirmed by their final release of the millennium, *Goodbye 20th Century* (1999). Rather than feature their own tracks, *Goodbye* presented a double CD of music by 20th century composers, including pieces by Takehisa Kosugi, Steve Reich and James Tenney, as well as Cage, Wolff and Cardew. Scores that were either graphic or written instructions compensated for the group's lack of strong sight-readers and introduced indeterminacy Steve Shelley (drums) explains:

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120 Century, Dan, "William S. Burroughs and Cut-up", 1/3/2004. http://www.legendsmagazine.net/104/william.htm

121 Copetas, Craig, "Beat Godfather Meets Glitter Mainman", original source unknown, 1974. http://www.algonet.se/~bassman/articles/74/brs.html

> For almost all of the music there were pieces of paper in front of us that were scores, but they were not for the most part traditional scores. They were more like directions or parameters.[122]

The Kosugi piece +- (plus/minus) presents a graphic score consisting of a grid of plus signs, minus signs and vertical lines, indicating to the players when to alter parameters accordingly (e.g., a plus could mean "raise pitch" or "increase duration", whereas a minus could mean "play softer" or "slower tempo"). How one moves from one symbol to the next is left to the individual and the duration of the piece is not specified.[123] In Cage's *Four*[6] (1992),

> Basically, each player, or musician gets a different score. On your score there are 12 numbers. For each of those numbers you have to assign a sound, or a tone, or a rhythm part. Once you assign a sound to each one of those numbers, you all use stopwatches. And it [the score] actually tells you when you can begin and end that sound. There is a minute variable each time. You can choose your entrance point and your exit point.[124]

The soundworld is multifarious. At times it sounds like industrial noise music and at other times like musique concrète (an attribute that is not altogether surprising considering the piece's structure is based on duration). Sonic Youth reduce the dichotomy between technique and non-technique identified by Martin by turning punk's refusal of technique into post-punk *extended* technique. This is confirmed to some extent by guitarist Jim O'Rourke, whose playing sets out to create a new musical vocabulary. But here lies a possible problem. While it might be preferable for an interpretation of Cage's music to adhere to his aesthetic for an impersonal music, O'Rourke's control over "mistake" sounds, that is to say, his deliberate incorporation of them into his playing, means it is full of personality and intention. The music sounds like post-rock experimentation, a deconstruction of the sonic properties of rock music, which is more or less what Sonic Youth have always done. Not that any of this was ever an issue when the album was

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[122] Garelick, Jon, "Space is the place: Sonic Youth are out of time" http://www.providencephoenix.com/archive/music/99/12/16/SONIC.html
[123] Winant, William, "*Goodbye 20th Century*: The Genesis of SYR 4", 1999. http://www.smellslikerecords.com/sonicyouth/6.php?cat_no=syr004
[124] Garelick, Jon, "Space is the place: Sonic Youth are out of time", 1999. http://www.providencephoenix.com/archive/music/99/12/16/SONIC.html

reviewed in the rock press; "Goodbye 20th century and goodbye career", lamented the *NME.*[125] The online music magazine *Pitchfork* described it as:

> [...] Music that is not supposed to be enjoyed so much as to be endured. To purchase this album is to purchase over an hour-and-a-half of some of the most abrasive noise imaginable outside of an industrial factory setting.[126]

Had Sonic Youth included detailed information on the pieces in the CD booklet, their critics might have been more inclined to listen. A similar problem exists with Stereolab, who operate an "aesthetic of accidents". Again, the idea goes back to Cage's aesthetics of non-intention and of "giving up control". The title of the group's second album, *Transient Random Noise Bursts With Announcements* (1993) reveals this aesthetic and prepares listeners for the unexpected. Tim Gane (guitarist):

> Clashes and accidents in the music are the things that make me most happy [...] I like to come out of a record and have it sound nothing like I expected it would. I want to divorce the fact that we made it. I want the least control as possible.[127]

Stereolab operate within the constraints of popular music, but their music is not one of detached and fragmented sounds, as one might assume from the above description, but of driving dance rhythms with little perceivable randomness. It is possible to see why Cage's desire that music be structured by duration, rather than pitch, might be attractive to those working in dance music, where beats rule and harmonic structures are minimal. But for Cage, the tolerance of mistakes and the pursuits of non-intention were aimed towards refusing musical memory and the self-referencing nature of music. Stereolab on the other hand, do not wish to wipe the slate clean; to them, randomness is a means to an end.

> I think there are musicians who make avant-garde music, and it doesn't really matter if anyone likes it, or listens to it in great quantities. Our music is certainly more addressed to people.[128]

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[125] Review of *Goodbye 20th Century* from the NME website, 2000. http://www.nme.com/reviews/3188.htm
[126] Sirota, Brent, "Sonic Youth: Goodbye 20th Century", *Pitchfork*, 2000. http://www.pitchforkmedia.com/record-reviews/s/sonic-youth/goodbye-20th-century.shtml
[127] Martin, Bill, *Avant Rock: Experimental Music from the Beatles to Bjork*, Open Court Publishing Company, 2002, p. 132.
[128] Ibid., 133.

2.3.5 Mike Patton: Mr Bungle and Fantômas

Vocalist Mike Patton shot to fame when he joined Faith No More in 1989 but his work with groups like Mr Bungle and Fantômas is far more interesting musically. Although Mr Bungle was Patton's high school band, he continued working with them throughout his time with Faith No More. Originally formed as a thrash metal outfit, Mr Bungle were more experimental than other bands working in the field. *Mr Bungle* (1990), their debut album produced by the jazz-rock experimenter John Zorn, combined a range of styles and genres. Like a modern day *Lumpy Gravy* (see page 101), the songs chop and change unpredictably between thrash metal, reggae, television advertisement jingles, free jazz, location recordings, soul, funk and scatology. The opening track, "Quote Unquote",[129] uses a dramatic dynamic shift to startle the listener. It begins with thirty seconds of someone snoring; this is purposefully low in the mix so the listener has to turn up the volume to really hear it. At 0:32 the mood is disturbed by what sounds like a light bulb popping, then, two seconds later, the peace is shattered by a deafening guitar chord and the beginning of the song. The follow up album, *Disco Volante* (1995), took Mr Bungle's eclecticism into new realms, fusing easy listening lounge music with powerful death metal outbursts. Patton's vocal range is tested to its full as he leaps from delicate falsettos to demonic screams within moments of each other.

In recent years, Patton's reputation as a rock composer has gained momentum. His current group Fantômas carry on where Mr Bungle left off, pushing the envelope of unpredictable rock music into new areas, in particular, a cartoon-style that one cannot imagine without Zappa's "The Adventures of Greggery Peccary".[130] Indeed, in June 2005, Fantômas performed in Sheffield with an ex-Zappa drummer, Terry Bozzio – one of the few able to perform heavy rock drumming with all the rhythmical twists and turns demanded by Patton's madcap score.

[129] Mr Bungle, "Quote Unquote", *Mr Bungle*, 1990.
[130] Frank Zappa, "The Adventures of Greggery Peccary", *Läther*, 1996.

2.4 SUMMARY

Within the various histories of music presented above, unpredictability has been traced through dice games, the avant-garde and popular music. Key aspects have been addressed, including aleatory and indeterminate approaches, which may be used in a wide variety of ways. Duchamp's early attempts at utilising chance in music may not have produced the most breathtaking results, but they were important for their innovation, made at a time when few other composers were using randomness. Several decades later Cage took randomness to new extremes in *Music of Changes* and also *4'33*, where the random sounds of the environment constituted music, effectively blurring the distinctions between life and art. Through the use of *I Ching* he was able to select parameter values by chance. Such ideas were unacceptable to Boulez who insisted the composer should maintain control over the work. In spite of this, Boulez eventually incorporated a degree of chance in open-work compositions inspired by Mallarmé. Although still markedly serial, they resolved issues of non-equivalence and prevented any further encroachment on automation. In a sense though, it was Xenakis who played the trump card, bypassing the whole Cage/Boulez discourse and turning instead to the mathematics of probability, including the laws of stochastics. The musical results were rich in colour and texture and because they were based on formalised procedures, Xenakis was well equipped to make the transition to the newly emerging computer age and thus secured his relevance for years to come.

In popular music unpredictability has also played a vital role, albeit a different one. In the 1960s, it fitted in with the counter-cultural values of the so-called "acid generation", when issues of freedom were big on the agenda of many artists. Groups like The Grateful Dead applied open-form ideas to rock music in pieces that were never performed the same way twice. In the 1970s, Eno applied musical strategies chosen at chance to his own music and went on to use the technique with bands he produced, including Bowie and Talking Heads. At the same time, Zappa was developing ways of fusing avant-garde music with rock 'n' roll, an undertaking that assimilated Cageian principles (among others) and that would be refined throughout his career. In popular music though, unpredictability is still a misfit component, rubbing up against the presupposed norms of what popular music should be like. The following chapter provides a thorough investigation of how Zappa employed avant-garde techniques with the aim of challenging the expected norms – a task which utilised a good deal of unpredictability.

CHAPTER 3

UNPREDICTABILITY IN THE MUSIC OF FRANK ZAPPA (1940-93)

This chapter discusses the various ways in which Frank Zappa integrated unpredictability into popular music. It is divided into three main sections and a summary. Section 3.1 discusses how Zappa introduced unpredictability into live performance. Section 3.2 explores some of his studio techniques associated with random generation and musique concrète, and section 3.3 investigates his so-called "Project/Object".

On stage, Zappa employed a number of techniques that would make each performance unique in some way. Audience participation was often used as a way of introducing an unpredictable "outside" element to the proceedings. Zappa's band was extremely well rehearsed, to the point where he was able to change the direction of a composition in an instant using a series of hand and body signals worked out in advance. Other aspects of live performance involved indeterminacy and some free improvisation. These are all discussed in section 3.1.

Zappa asserted a high level of control in the recording studio, the subject of discussion in section 3.2. On his early albums he applied techniques associated with musique concrète to construct surreal passages, containing rapid successive edits and unpredictable jump-cuts. On later releases he experimented with a technique called xenochronicity, which allowed him to overdub unrelated tracks, often played at different tempi. By the 1980s, many of his compositional experiments were realised on a Synclavier, a computer music workstation; Zappa capitalised on its ability to faultlessly perform his most difficult scores, but also investigated ways of introducing a more "human" feel.

Whereas the techniques discussed in sections 3.1 and 3.2 can be applied to specific pieces of music, section 3.3 discusses a cryptic aspect of his work, which applies across his oeuvre. Zappa's albums often contained thematic cross-references to other albums, forming a web of links between works he termed "conceptual continuity". On the material surface, subject matter may be perceived as obscure until the hidden meaning is discovered elsewhere, e.g., on another record. It is argued that this is a quasirandom technique based on a complex, yet intentional, ordering system, and one requiring unravelling if the true meaning of his work is to be extracted.

3.1 UNPREDICTABILITY IN PERFORMANCE

The unpredictability that marked the performances of Zappa's band, The Mothers of Invention, was groundbreaking in its day. Their first album, *Freak Out!* (1965), was an eclectic double album and included electric blues (e.g., "Trouble Every Day"), novelty songs (e.g., "Wowie Zowie") and parodies of doo-wop (e.g., "Go Cry on Somebody Else's Shoulder"). Other tracks, such as "Hungry Freaks Daddy", had a grittier realism to them; whilst the lyrics scorned American society, the music was uncompromising and difficult to penetrate for those whose main contact with music was through mainstream radio and television programmes. The first three sides contain well-observed parodies of the culture industry's popular music output, the type of music described by Adorno as novelty songs, songs that "have always existed on a contempt for meaning which, as predecessors and successors of psychoanalysis, they reduce to a monotony of sexual symbolism".[1] The fourth side of the album was filled with a bizarre, electronic ballet called "Return of the Son of the Monster Magnet";[2] there were no signs of standardisation or pseudo-individualisation here. It introduced a number of techniques Zappa would return to and refine over the years, such as using tape editing to join together recordings in an

[1] Adorno, Theodor and Horkheimer, Max, *The Dialectics of Enlightenment,* 1944, p. 138.
[2] Frank Zappa, "Return of the Son of the Monster Magnet", *Freak Out!*, 1965.

unpredictable manner. It also demonstrated his desire to deviate from "the norm", without which, he believed, progress was not possible.[3]

Zappa used many strategies to expose the limitations of the Top 40 song format, and in doing so, proved there were ways around the steadfast formulas of popular music. Techniques included improvisation (free or structured), the use of asymmetric rhythms (e.g., 5/4 and 7/8), irregular song structures, references to classical music and the avant-garde, and satirical music theatre. Whether or not his musical objective was a realisation of Adorno's polemics against "standardisation" and "pseudo-individualisation" is debatable; nonetheless, Zappa tackled these issues head on in setting out to prove that popular music could be a vehicle for progressive ideas without alienating its audience.

Throughout his career, Zappa toured extensively, and his fondness for indeterminacy meant no two concerts were ever the same. He was a compulsive archivist and stored hundreds of hours of live concert material on tape in three vaults beneath his house. During the late 1980s he released a six-volume CD set of over 13 hours of this material entitled *You Can't Do That On Stage Anymore*. It spanned 20 years and, according to him, it only scratched the surface of what he viewed releasable material. At the time of writing, the number of official releases stands at 74, but the number continues to rise due to the efforts of the Zappa Family Trust. With so much material to choose from, section 3.1 aims to highlight key examples and expose the variety of techniques Zappa incorporated into live performance to generate unpredictability.

3.1.1 Anything, Anytime, Anywhere – For No Reason At All

The origins of Zappa's interest in unpredictability possibly stem from his love of Stravinsky's *Le Sacre du printemps* – its combination of irregular meters and shifting

[3] Zappa, Frank with Occhiogrosso, Peter, *The Real Frank Zappa Book*, Picador, London, 1989, p. 185.

rhythmical accents make counting the beats a difficult task, a characteristic shared by Zappa's complex rock; however, a more radical philosophy is also at work. The motto of the staff that worked with Zappa at his studio was "Anything, Anytime, Anywhere – For No Reason At All". This is also a good summary of the way he deployed improvisational strategies in live performances and recordings throughout his career. The purpose of embracing different types of improvisation as well as audience participation was to forge a unique experience at concerts. It is no coincidence that Zappa appeared on the Cage tribute CD, *A Chance Operation* (1993), on which he performed *4'33"*.[4]

> Without Cage, Zappa said, much of what takes place in modern music and art "would not be possible".[5]

In the late 1960s, Zappa pointed to Cage as the inspiration behind an indeterminate piece of music theatre in which Mothers' saxophonist, Motorhead Sherwood, talked banally about working in an aeroplane factory, doing-up cars, and his various girlfriends.[6] That Zappa was using Cage's strategies within popular music made them especially resonant since in this context they found a new audience. But although Cage's influence on Zappa is clear, there are also a number of fundamental differences between the two composers. Whereas Cage wanted to free musicians from the authorship of the composer, Zappa employed musicians to play his music. He insisted throughout his career that music came from composers, not from performers, but that when a musician improvised they became a composer.[7] Marco Maurizi writes:

> Zappa shared the same opinion [as Cage] about the nature of the musical event: there is no wrong sound in itself. [...] Nevertheless, it was all material that needed a composer, he always considered it a matter of choice, of intention, precisely what Cage abhors.[8]

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[4] Zappa initially turned down the invitation to take part because of his busy work schedule. The album's producer eventually persuaded him on grounds that it need only take 4'33".
[5] *Los Angeles Times*, 1 October 1992. Interview with Frank Zappa. http://www.science.uva.nl/~robbert/zappa/interviews/LA_Times.html
[6] Courrier, Kevin, *Dangerous Kitchen: The Subversive World of Zappa*, EWC Press, Toronto, 2002, p. 131. This piece was eventually released on *Lumpy Gravy* in 1968.
[7] Zappa, Frank with Occhiogrosso, Peter, *The Real Frank Zappa Book*, Picador, London, 1989, p. 174.
[8] Maurizi, Marco, "Ears from Utopia, Adorno meets Zappa: A Metacritique of avant-garde", unpublished paper, 1999.

Understanding the excitement unpredictable forms of behaviour could bring to a live event, Zappa encouraged concert audiences to get involved. This often resulted in some form of unplanned mayhem. During a concert at the Royal Albert Hall in 1968, a member of the audience climbed on stage with a trumpet. Possibly making the mistake that free jazz was easy to play, the interloper was left flailing behind when the band joined in. Zappa captured the whole incident on tape and released it on *Uncle Meat* (1969).[9] Recordings of live events also captured the occasional audience outburst or some other kind of random interruption to a well-rehearsed show. The unsettled fan heard shouting from the back of the concert hall at the end of *Burnt Weeny Sandwich* (1970) was a forerunner of the rioting Italian audience Zappa dealt with at the end of the 1982 tour.[10] This willingness to exploit the relationship between artist and audience draws parallels to the dadaists, who thrived on provocation. Indeed, Zappa once referred to The Mothers' concerts as "carrying on the forgotten tradition of dada stagecraft. The more absurd, the better I liked it".[11] This is true of the twice-nightly residency The Mothers held at the Garrick Theatre, New York in 1967. The show was called *Pigs and Repugnant*. Watson describes it as Zappa's Cabaret Voltaire,[12] but it was inspired as much by the experimental goings-on of Black Mountain College. Ruth Underwood, a percussionist with Zappa between 1972-76, recalled the riotous, unpredictable concerts at the Garrick Theatre she attended before joining the band.

> One never knew what to expect, there were some nights that you just heard pure music, and other nights, Motorhead'd be talking about fixing his car, with Jim Black's drum beat in the background. Sometimes Frank would just sit in a chair and glower at the audience. [...] I remember Stravinsky being played, I remember droning music going on for ages, and then in the middle of all of that, the song that then became 'Oh No, I Don't Believe It', sort of breaking through the clouds.[13]

Initially, audience attendance was high, but over the weeks, the numbers began to dwindle. On one occasion, when it was especially low, Zappa asked the audience if they would like to

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[9] Frank Zappa, "Louie Louie", *Uncle Meat*, 1969.
[10] Frank Zappa, "Cocaine Decisions", *You Can't Do That On Stage Anymore, Vol. 3.*, 1988.
[11] Frank Zappa interviewed in Playboy Magazine, 1993.
http://zappa.rockmetal.art.pl/wywiady/playboy.htm
[12] Watson, Ben, *Frank Zappa: The Negative Dialectics of Poodle Play*, Quartet Books, London, 1993, p. 87.
[13] *Late Show Special* broadcast on BBC2 on Friday 17 Dec 93.

be the band for the night. This indicates his openness to the idea that new musical vocabularies could be arrived at without necessarily the need for good technique.

> They thought it was a good idea, so we gave them our instruments, sat in the audience for an hour and a half and listened to them play the show.[14]

Speaking retrospectively in 1991, Zappa spoke of the way that the content of entire concerts (e.g., which pieces to play and in what style) would sometimes be improvised:

> [...] A lot of times we would go on and not know exactly what we were going to do. We'd just start the show and keep going for an hour, hour-and-a-half, and find out what happened at the end of the show.[15]

Dada was certainly part of the routine when Mothers' pianist Ian Underwood performed Mozart's *Piano Sonata in B Flat*, whilst other members of the group danced a random ballet and made chicken noises.[16] Ironically, Zappa was only able to take such risks because his band was so well rehearsed. Another dadaist incident occurred during a performance of "Don't Eat The Yellow Snow"[17] at the Hammersmith Odeon in 1979, the entire audience were instructed to "stand up and recite a poem". Zappa referred to it as "enforced audience participation". At one concert, held in an Illinois sports hall, Zappa divided the audience of five thousand into five sections (based upon how the seats fanned out) and had each section sing a different well-known melody.[18] There were shows when Zappa would stage dance contests. Members of the audience would be invited on stage to dance in an unconventional manner. On one occasion, during the "Be-bop Tango (of the Old Jazzmen's Church)", contestants were asked to restrict their dance movements to coincide with the quick and unpredictable melodic fragments performed by George Duke on the electric piano.[19]

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[14] Zappa, Frank with Occhiogrosso, Peter, *The Real Frank Zappa Book*, Picador, London, 1989, p. 98.
[15] Zappa speaking on *Midweek*, BBC Radio 4, September 1991; transcription by the author.
[16] Frank Zappa, "Mozart Ballet - Piano Sonata in B Flat", *You Can't Do That On Stage Anymore, Vol. 5.*, 1992.
[17] Frank Zappa, "Don't Eat The Yellow Snow", *You Can't Do That On Stage Anymore, Vol. 1.*, 1988.
[18] Ibid., p. 178.
[19] Frank Zappa, "Be-Bop Tango", *Roxy and Elsewhere*, 1974.

3.1.2 Conducted Improvisation

Zappa developed a form of conducted improvisation as far back as 1963, when a concert of his classical works at Mount St. Mary's College, Los Angeles featured a piece which included a hand signal for free improvisation and finger signals to indicate which fragments of written music to play.[20] He continued to develop these ideas over the years with his various bands and encounters with orchestral ensembles.

> If I pretend to twirl braids on both sides of my head, it means: "play ska" [...] During any song, no matter what style it was learned in, on a whim I can turn it around and do something like that, and the band will restyle the tune.[21]

Butch Morris, the innovative jazz musician who coined the expression "conduction" or "conducted improvisation" has used a similar method of controlling improvisation since the mid 1970s. He defines it as "a means by which a conductor may compose, (re)orchestrate, (re)arrange and sculpt with notated and non-notated music".[22] Morris's ability to conduct a vocabulary of signals helps him to shape the sounds improvised by his musicians.

Zappa's method developed along similar lines, in the sense that his signals could be used to trigger pre-rehearsed musical events and vocal noises. Footage of Zappa rehearsing with the Ensemble Modern demonstrates this. Upon a hand signal the ensemble cry "eeh!" in unison. "Now," says Zappa, "you have to remember these things, 'cus they can happen anytime".[23] Such techniques allowed Zappa to change compositions at any point during their performance, making his conduction not only unpredictable for audiences but also performers. The movie *Baby Snakes* (1979) contains a long section of Zappa using conduction. Many of the signals are simple, e.g., pointing a finger downwards = "play lowest note". To signal to the keyboardist to play randomly, Zappa is seen wiggling his fingers in an erratic manner.

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[20] Frank Zappa, "Mount St. Mary's Concert Excerpt", *The Lost Episodes*, 1996.
[21] Zappa, Frank with Occhiogrosso, Peter, *The Real Frank Zappa Book*, Picador, London, 1989, p. 167.
[22] Heining, Duncan, "Surrender to the Music: Lawrence D. 'Butch' Morris", *Avant*, Issue 4, Soundworld, Chelmsford, winter, 1997, p. 46.
[23] *Late Show Special* broadcast on BBC2 on Friday 17 Dec 93.

3.1.3 "Eyebrows"

Sometimes, during rehearsals or sound checks, a humorous mistake would end up permanently incorporated in a song, as part of an alternative arrangement defined as the "eyebrows" of the composition.

> I'll hear a hint of something (often a mistake) and pursue it to its most absurd extreme. The technical expression we use in the band to describe this process is: "**PUTTING THE EYEBROWS ON IT**".[24]

From their outset, The Mothers of Invention used "in-jokes", often based on word play and contextual substitutions, to create surrealism (these would often contribute to the cryptic element of Zappa's Project/Object discussed in section 3.3). The song "Duke of Prunes"[25] (itself a pun on the song "Duke of Earl" by Gene Chandler[26]) contains the line, "Moonbeam through the prune, in June". Ray Collins recalled that Zappa's original words were, "Moonbeam through the night, in June",[27] but that, by using the original words as a trigger for surrealist humour, Collins was able to interpret them like an open score (although he remained faithful to the rhythmical and melodic elements supplied by Zappa). It was the strategy used to shock listeners raised on the pre-listened, pop music of commercial radio. Lyric mutation happened regularly on tour. Under the pressure of performing shows in different locations every night, three months at a time, it was as much a way of relieving the boredom of repetition as it was a method of introducing indeterminacy into the song words. Ex-Turtles' singers Mark Volman and Howard Kaylan, who joined The Mothers in 1970, became well known for their ability to free associate. A number of comedy routines were developed which allowed them to ad lib within a predetermined framework. This can be demonstrated by comparing three different performances of "Billy the Mountain" in which time always passed in a different way.

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[24] Zappa, Frank with Occhiogrosso, Peter, *The Real Frank Zappa Book*, Picador, London, 1989, p. 164. This quote also exemplifies word emphasis through the expressive use of typeface (the printed version of eyebrows), which occurs throughout Zappa's book.
[25] Frank Zappa, "Duke of Prunes", *Absolutely Free*, 1967.
[26] Courrier, Kevin, *Dangerous Kitchen: The Subversive World of Zappa*, EWC Press, 2002, p. 112.
[27] Ibid.

> Time passed...January, February, March, July, Wednesday, August, Irwindale/2:30 in the afternoon, Sunday, Monday, funny cars, walnut, city of industry, Big John Masmanian... So when the phone rang in the secret briefcase... (7 August 1971, UCLA)[28]
>
> Time passed...January, March, 1943, Capricorn, Your mother's Mustang, Easter Sunday. And then the phone rang in the secret briefcase... (16 October 1971, Stonybrook University)[29]
>
> Time passing (right!)... January, February, 1975, 1986, March, 1914... So when the phone rang in the secret briefcase... (5-6 June 1971, Fillmore East)[30]

This example is also interesting because it draws attention to Zappa's view of time as a spherical constant, where everything is happening all the time; as opposed to the idea that time passes linearly (from past, to present, to future).

3.1.4 Meltdowns

Zappa's term "meltdown" is a direct reference to the chain of events known to cause a nuclear reactor's core to melt. In the 1980s, meltdown also had economic connotations, with the boom and bust Thatcher/Reagan era culminating in recession. Zappa's musical equivalent usually occurred in the middle of a song. While his band members freely improvised, dissolving bar-lines and time signatures, Zappa would recite some lyrics or improvise some verbiage in a manner he referred to as "singsong tone of voice". The idea behind the meltdown came from Schönberg's *Sprechgesang* (speech singing), a vocal technique halfway between speaking and singing in which the vocalist slurs to and from pitches, with a degree of approximation. Schönberg famously used the technique to enhance the otherworldly combination of clowns and moonlight in *Pierrot Lunaire* (1912). Zappa seems to take it a step further on the song "It Can't Happen Here";[31] although, he is not directly referencing Schönberg, the words are sung in a suitably slurred speaking/singing voice, at times backed up by percussive vocal noises. A transcription

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[28] Watson, Ben, *Frank Zappa: The Negative Dialectics of Poodle Play*, Quartet Books, London, 1993, p. 267.
[29] Ibid.
[30] Frank Zappa, "Billy The Mountain", *Playground Psychotics*, 1992.
[31] Frank Zappa, "It Can't Happen Here", *Freak Out!*, 1965.

score from the 1980s voices it for "five vocalists, piano and drumset", but on the original recording, Zappa overdubbed the parts himself. It is tempting to speculate that much of "It Can't Happen Here" was arrived at through trial and error, and the fact that only a transcription score is available seems to confirm this. Much of the piece sounds improvised, built up in stages around a foundation track containing the main vocal line. On *Absolutely Free* (1967) the technique is used in "America Drinks".[32] In this case there is a stronger sense of melody; however, *Sprechgesang* pitches, sung by Ray Collins, seem to be arrived at by accident rather than intention. Zappa's appreciation of the avant-garde and popular music gave him a platform from which he could expose how the two worlds often collided. The song "Flakes"[33] features Adrian Belew impersonating Bob Dylan and serves to highlight how a Sprechgesang-style of singing managed to find a popular outlet, not just in Zappa's funny-voice technique, but also in Dylan's distinctive semi-spoken voice of protest.

Tinsel Town Rebellion (1981) contained the first recorded example of a meltdown but the best examples, "The Dangerous Kitchen" and "The Jazz Discharge Party Hats", appeared on *The Man From Utopia* (1983). Although these are very free, they do not sound completely unpredictable (see *figures 3-1* and *3-2*). In each case, the words tell a story, accompanied by music with a jazz-like feel. However, the levels of indeterminacy at work are high, as Zappa explained:

> We have this thing called meltdown, where, depending on what's in the news of the day, or what happened in the audience during the show, I'd start talking in singsong tone of voice and then Tommy Mars would chop changes behind it. Now that's very freeform, kind of like "The Dangerous Kitchen" or "The Jazz Discharge Party Hats"; those both are meltdown events. In the case of "Dangerous Kitchen", it's a fixed set of lyrics that has variable pitches and variable rhythms. In the case of "The Jazz Discharge Party Hats", it was completely spontaneous, 100% improvised by me and the band. It ended up right on the spot in this concert in Illinois.[34]

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[32] Courrier, Kevin, *Dangerous Kitchen: The Subversive World of Zappa*, EWC Press, Toronto, 2002, p. 114.
[33] Frank Zappa, "Flakes", *Sheik Yerbouti*, 1979.
[34] Slaven, Neil, *Electric Don Quixote*, Omnibus, London, 1996, p. 260, citing an interview by Rick Davis, "Father Of Invention", *Music Technology*, February 1987.

No two days share the same headlines, so by choosing news stories as the source of meltdown material, the experience would be different at each performance. The duration of a meltdown was therefore indeterminate, depending on the length of time it took to convey the story. When "The Dangerous Kitchen" and "Jazz Discharge Party Hats" were released, guitarist Steve Vai had transcribed Zappa's *Sprechgesang* vocal line (with its indeterminate pitches and rhythms), learnt it on the guitar and overdubbed it onto the original recording. This gave the illusion that Zappa was scat singing and playing his guitar in perfect unison, but it was a match that never actually took place. The transcription was very thorough and Zappa was delighted when, in "Party Hats", Vai

> [...] even put in a string-scratch for when I laughed! I went "Huh, huh, huh" and he's got that little "scrape, scrape, scrape" in there.[35]

Zappa was able to create a musical illusion in the recording studio. With Vai's guitar following him word-for-word, what is perceived is a kind of heightened reality of an event (Zappa scatting) that never actually took place. Since it is a very separate process to the meltdown, it poses a problem when trying to visualise the unpredictability of the piece. For this reason, the following three-dimensional representation (see *figure 3-1*) does not take Vai's overdub into account, but instead concentrates on the meltdown aspect of "The Jazz Discharge Party Hats".

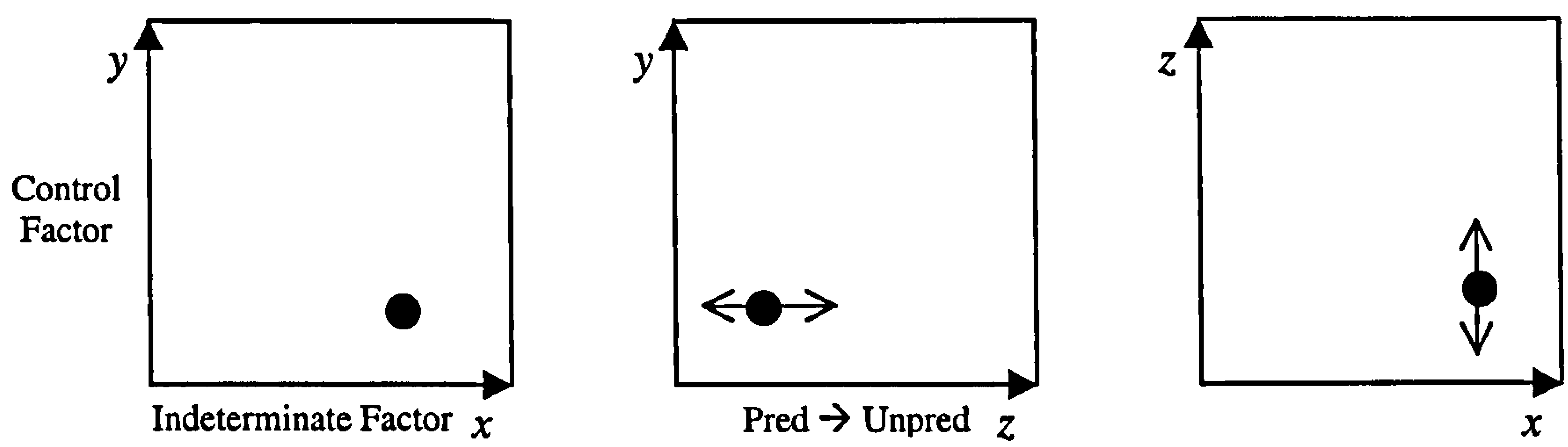

Figure 3-1: Degrees of unpredictability, in process and perception, in "The Jazz Discharge Party Hats"

[35] Mead, David, "Frank Zappa: Unholy Mother", *Guitarist*, Guitarist Publishing, June 1993, p. 26.

The x-axis represents the indeterminate factor, i.e., those decisions left to the performers. This is high but at the same time it is not total, for example, the drums and bass provide an identifiably be-bop accompaniment which was most likely planned in advance. The y-axis represents the amount of control exerted by Zappa (low in this instance) and the z-axis represents the degree to which unpredictability may be perceived. Although highly indeterminate, the jazz feel of the music and use of humour to convey the story results in the piece sounding, in general, fairly predictable. The meltdown (on this occasion at least) produced quasiorder.

An offshoot of transcribing an improvisation is the ability to replicate it, as indeed happened in 1991 when Mike Keneally, Zappa's 1988 tour guitarist, performed "Party Hats" during the Zappa's Universe concert. While Keneally's vocals and guitar are fixed to the transcription, the other members of the group are free to improvise. But unlike the original "completely spontaneous" version, this one has an enhanced sense of structure. Certain vocal lines are picked out by the band, for example, the lines, "...get it in there – you know what I mean" and "Hey, let's go skinny dipping" are noticeably accented by the drummer. Keneally uses a hand signal to halt the band just before he delivers the line, "Well – one of the guys in the band picked up her panties", at which point they perform a clichéd love-song harmony; such moments are clearly planned in advance. As the song moves towards its conclusion the group become increasingly syncopated, adding importance to the words with a rhythmical highlighter pen. Watson writes that "Party Hats", with its lyrics about knicker fetishism, leaves him feeling "inert", but it works as an example of indeterminacy, where the only controlled parameter is the subject matter of the vocal improvisation.

3.1.5 "Approximate"

The first public performance of "Approximate" took place on 10 September 1972 at the Hollywood Bowl, home of the easy listening 101 Strings Orchestra. Third on the set list, Zappa described it as the most "far-out"[36] piece performed. Four parts are shared between twenty musicians (generating an arrangement in much the same way as Feldman's *Intersection I*; see page 57). Zappa explained the process to his audience:

> There's only four parts that are dispensed among 20 musicians for this piece. There is one page that is for all instruments in C and F, including percussion. There's another page for all the instruments in E-flat and B-flat and elsewhere and then there's a bass part and a drum set part, which combine the rhythms of the other two. The only thing that is indicated in the score is [...] the exact rhythm, that is supposed to happen for most of the piece and all players get to choose their own pitches that they play. So... it randomises a certain bit.[37]

"Approximate" is a good example of a quasiorder piece governed by a strong sense of rhythm and structure to co-ordinate the musicians; the fact that most of the pitches are indeterminate is barely detectable for reasons that will be explained. Subsequent versions of "Approximate", performed by various incarnations of Zappa's rock band, have since been released, with one on *Zappa In New York* (1977) and two others on *You Can't Do That On Stage Anymore, Vols. 2 & 4* (1988). There is also a version on the video release *Dub Room Special.*[38] The score, the majority of which omits pitch information, contains the type of rhythmical intricacy Zappa went on to perfect in pieces like "The Black Page".[39] By removing the importance of pitch, the score is open to interpretation by any instrument, allowing an unusual type of flexibility when generating arrangements. In the *Stage II* version, Zappa turns it into movement theatre, his band performing the score with their feet. There is also a version for voice, in which singing the most painful dissonances would seem to be the prerequisite.

In later versions, the indeterminacy of "Approximate" seems to be less of a feature. The speed of the 1974 Mothers' rendition indicates that initial note choices, possibly decided upon during rehearsals, had become fixed parts of the score, there being a less noticeable

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[36] Review from *Oor* magazine, 27 September 1972, translated from Dutch by Jillis Stada (edited by Charles Ulrich).
[37] This comes from a bootleg recording of Zappa at the Hollywood Bowl, 10th September, 1972.
[38] Frank Zappa, *Dub Room Special*, Honker Home Video, 1982
[39] Frank Zappa, "The Black Page", *Zappa in New York*, 1977.

level of variation between different performances. Arthur Barrow, Zappa's eighties bass player, contests this:

> Like most of his music, Frank was always experimenting and changing things. Perhaps some players picked random notes they stayed with, but I think they mostly stayed random.[40]

Initial investigations conducted without a score involved comparing the *Stage 2* version with the *Stage 4* version to differentiate between improvised and composed pitches. This proved problematic, with both versions structurally at odds and performed at dramatically different tempi. Close listening revealed a number of mutual characteristics. Both versions share the introductory three-and-a-half bar long reiterated B-flat motif, which instantly establishes itself as the tonal centre. Zappa stated that the fixed pitches were deployed "for the sake of contrast",[41] but the influence they have is much greater, since they contain some of the longest durations of the piece.[42] The majority of the random pitches occur in jittery groups of semiquaver tuplets, which move too fast to establish any tonal stability. Despite this, there are moments in both versions that sound distinctly like descending sequences;[43] the *Stage 2* version even sounds like it contains repeated phrases. To represent "Approximate" using the three-dimensional approach (see *figure 3-2*), these factors need to be taken into account. Since pitch is the only parameter improvised, the degree of control (*y*-axis) exerted over the other parameters is total (i.e., composed by Zappa); the amount of performer input (*x*-axis) required to perform the piece is also substantial, with the majority of notes requiring a pitch chosen freely. The perception of this unpredictable factor (*z*-axis) is eclipsed somewhat by Zappa's complex, composed rhythms.

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[40] Arthur Barrow on "Approximate" in correspondence with the author, 6 December, 2002. Arthur kindly answered questions and provided a scan of "Approximate" (for study purposes only!) upon which many of these new revelations are founded.

[41] Chevalier, Dominique, *Viva Zappa*, Omnibus Press, London, 1986, p. 113, citing The Grand Wazoo's tour programme, 1972.

[42] The experiments of Lantz and Cuddy conclude that the duration, rather than the rate of recurrence of a pitch, plays a more crucial role in establishing the tonal centre. Lantz, M.E. and Cuddy, L.L., "The Effects of Surface Cues in the Perception of Pitch Structure; Frequency of Occurrence and Duration", *ICMPC proceedings* (1996), pp. 281-286.

[43] Occurring from 18 to 21 seconds in the *Stage 2* version and from 33 to 37 seconds in the *Stage 4* version (time measured from first note of each piece).

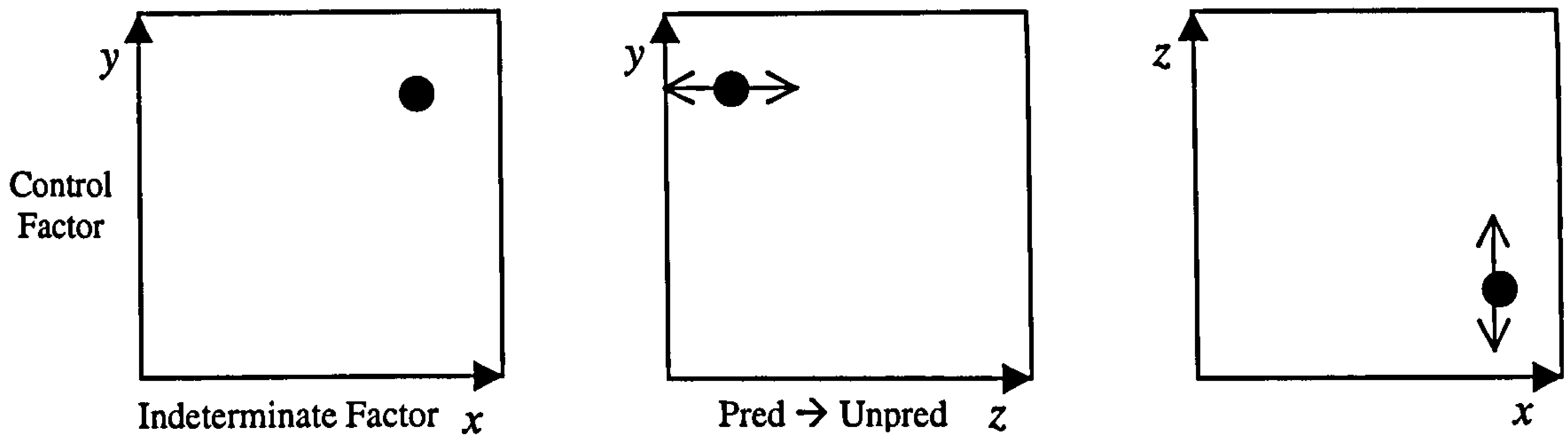

Figure 3-2: Degrees of unpredictability, in process and perception, in "Approximate"

When Zappa told his audience that the piece was randomised a "certain bit", he was talking about the degree of randomness: the dichotomy between the pitches with a designated register and those of the approximate melody left for the musicians to decide. Upon analysis of the score, the process becomes clearer. Using a traditional staff, a series of markers (shown as crosses, instead of dots) indicate a predetermined, melodic contour.

> These are markers that show, by their positions, the approximate register for each instrument.[44]

With the approximate shape of the melody given, the musicians simply follow its undulations. This provides a possible explanation why the listener can perceive sequences and repetitions; musicians often play melodic shapes on their instruments, and these can easily be transposed at random intervals. In larger ensembles, such features would be less obvious due to the increased timbral density caused by there being a greater number of instruments. Interpretation of the score becomes interesting during moments when the melodic contour levels out. These flat sections give the impression that a random pitch ought to be repeated, and this is what happens in both *Stage* versions. However, there are no instructions in the score to suggest this is the case, leading one to conclude that in fact, it merely implies the same degree of randomness as elsewhere in the score.

[44] Chevalier, Dominique, *Viva Zappa*, Omnibus Press, London, 1986, p. 113.

3.2 TECHNOLOGY-BASED PROCEDURES

This section examines how Zappa used technology in the creation of music which contained either randomness or quasirandomness.

3.2.1 Musique Concrète

Although these days the album *Lumpy Gravy* is characterised by its use of dialogue interspersed with sections of orchestral music, popular music and musique concrète, it was originally conceived as a completely orchestral album. When Capital Records approached Zappa to compose music for a 40-piece ensemble, he was signed to MGM, but his contract did not preclude him from conducting or composing on another record labels, providing he did not play or sing. Even so, upon the record's completion, MGM blocked its release and, after a year of legal wrangling, bought the master tapes from Capitol. It was at this stage that Zappa added the sections performed by The Mothers of Invention, the musique concrète fragments and the voices from inside a piano. On the album cover he referred to it as "a curiously inconsistent piece";[45] in fact, it is beautifully balanced.

> One day I decided to stick a pair of U-87's in the piano, cover it with a heavy drape, put a sand bag on the sustain pedal and invite anybody in the vicinity to stick their head inside and ramble incoherently about the various topics I would suggest to them via the studio talk-back system.[46]

As participants spoke, sympathetic strings inside the piano would vibrate, producing a pan-chromatic resonance. After several days of recording the conversations, Zappa planned to edit them down "to create the illusion that various groups of speakers, recorded on different days, were talking to each other".[47] The main problem he faced was preventing the piano ambience vanishing abruptly at the edit point. This practical issue, which revealed the

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[45] Sleeve notes to *Lumpy Gravy* (1968)
[46] Sleeve notes to *Civilisation Phaze III* (1994)
[47] Ibid.

limitations of magnetic tape as a truly liberating medium, ultimately restricted how much of the dialogue he could use.[48]

When it was eventually released (spending a week at number 159 in the U.S. charts) it had undergone a radical shift from the original concept. *Lumpy Gravy* had become a sound collage, making extensive use of the tape manipulation techniques associated with musique concrète: abrupt jump-cuts, altered tape speeds, backwards masking, electronic filters and effects. Zappa had already demonstrated his skills as an editor on *Freak Out* and *Absolutely Free* but this represented a far more radical treatment of materials. Although Varèse's influence is very noticeable in both the orchestral and musique concrète sections – some of which sound remarkably like *Poème électronique* (1957-58) and the tape section of *Déserts* (1950-54) – Zappa's musique concrète has more in common with that of its pioneer, Pierre Schaeffer. Unlike Varèse, Schaeffer did not use synthesised electronic sounds, preferring to base his art on the manipulation of sounds already in existence.[49] Zappa understood this important distinction, writing on the album sleeve of *Lumpy Gravy*, "None of the sounds are generated electronically… they are all the product of electronically altering the sounds of NORMAL instruments".[50]

Courrier makes the observation that listening to *Lumpy Gravy* is an experience "akin to spinning a dial on a radio – you might hear a snippet of dialogue, a bit of surf music, then suddenly a string quartet".[51] It is therefore reminiscent of Cage's works, *Imaginary Landscapes* and *Radio Music* (1956), which utilize the random qualities of radios to bring about unpredictability – reminiscent, but not the same. The materials on *Lumpy Gravy* are organised. In the most basic sense, its macrostructure can be defined as an alternation between blocks of instrumental music (some of which are spliced together from different recordings, having undergone tape speed alterations), musique concrète (sections of music containing lots of edits) and spoken word. What becomes apparent on closer inspection is

[48] This problem was eventually solved 25 years later with digital editing software.
[49] Watson, Ben, *The Complete Guide to the Music of Frank Zappa*, Omnibus Press, London, 1998, p. 70.
[50] Sleeve notes to *Lumpy Gravy*.
[51] Courrier, Kevin, *Dangerous Kitchen: The Subversive World of Zappa*, EWC Press, Toronto, 2002, p. 130.

that this macrostructure does not coincide with the track index (see page 310). For example, track four, "A Bit Of Nostalgia" starts near the beginning of a block of musique concrète and leads into a block of spoken word. Track five, "It's From Kansas", starts with the last sentence from a block of spoken word, is followed by a brief section of trad jazz and ends at the beginning of a large section of musique concrète. In terms of how the music is perceived, the track index blurs the boundaries of the sections of music, superimposing a grid, offset with the surface it covers. Masking the start and end points of each section has little influence on the perception of unpredictability when listening to the album all the way through, but tracks played in isolation reveal a quasirandom technique at work, akin to changing the positions of spaces in a sentence, e.g., a kintoch anging thepo sit ions of spaces inasent ence.

For the most part, it is down to Zappa's extensive editing and sudden changes of direction, not randomisation, that make it unpredictable listening. With the exception of a few jaunty tunes, there is also a marked absence of repetition on *Lumpy Gravy*. It is striking that there is no detectable use of tape looping. Six months after *Lumpy Gravy* was released, The Beatles released the *White Album*. According to Lennon, "Revolution No. 9" used tape loops extensively:

> It has the basic rhythm of the original "Revolution" going on with some twenty loops we put on, things from the archives of EMI. We were cutting up classical music and making different size loops, and then I got an engineer tape on which some test engineer was saying, 'Number nine, number nine, number nine.' all those different bits of sound and noises are all compiled. There were about ten machines with people holding pencils on the loops - some only inches long and some a yard long. I fed them all in and mixed them live.[52]

Out of all the techniques of musique concrète, tape-looping has been assimilated by popular music the most. The Beatles first used it on *Revolver* (1966). Eno used signal looping on the soundtrack to film *Berlin Horse* (1970) and continued to use loops throughout his career, most famously on *Music for Airports* (1978), but also on collaborations with the guitarist Robert Fripp on *No Pussyfooting* (1973) and with David Byrne on *My Life In The*

[52] Miles, B., *Paul McCartney:Many Years From Now*, Secker & Warburg, London, 1997, p. 484.

Bush Of Ghosts (1981). Steely Dan used drum loops on *Gaucho* (1980). In light of Zappa's views on minimalism (its popularity based on the subtext that it is cheap to produce, rehearse and mount, and intellectually undemanding[53]), his aversion to loops is not surprising.

There is no obvious use of looping in Zappa's body of work until *Thing Fish* (1984) when he looped a guitar riff on the Synclavier. His interest in the techniques associated with musique concrète stemmed from his knowledge of Varese's music and a desire to extend the principles of organised sound to popular music. It is fair to say that Zappa preferred to use tape both to create unpredictability and to isolate singularities (rather than to repeat them over and over again).

3.2.2 Xenochronicity (Strange Time)

As far back as 1966, Zappa was experimenting with multiple colliding themes. The idea is most famously associated with Charles Ives, who used it to give the illusion of several marching bands playing at once. Zappa used it at the end of "Call Any Vegetable":[54]

> [...] the band splits into three parts, playing "The Star-Spangled Banner", "God Bless America" and "America the Beautiful" all at the same time.[55]

Since then, it has been used by a number of popular music artists. Prince used it during the opening of "Christopher Tracy's Parade"[56], when an orchestral arrangement and electronics enter out of sync with each other. Queen used it at the beginning of "Brighton Rock"[57] when

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[53] Frank Zappa interviewed by Bob Marshall, October 1988. http://www.science.uva.nl/~robbert/zappa/interviews/Bob_Marshall/Part09.html
[54] Frank Zappa, "Call Any Vegetable", *Absolutely Free*, 1967
[55] Zappa, Frank with Occhiogrosso, Peter, *The Real Frank Zappa Book,* Picador, London, 1989, p. 167.
[56] Prince, "Christopher Tracy's Parade", *Parade*, 1986, Paisley Park.
[57] Queen, "Brighton Rock", *Sheer Heart Attack*, 1974.

a field recording of a street organ is met with Brain May playing his electric guitar at a different tempo.

Zappa's album *Zoot Allures* (1976) introduced a technique called variously "re-synconisation"[58] or "xenochronicity",[59] where instrumental lines played by musicians without reference to each other (sometimes separated by years) are merged together in a multi-track studio. When Zappa's guitar enters at the start of "Friendly Little Finger"[60] it is noticeably playing to a different rhythm. Watson calls the result an "exotic schizophrenia...not average chaos but highly individualised music".[61] The technique next appeared on *Sheik Yerbouti* (1979) on the track "Rubber Shirt". Zappa supplied the following insight:

> The bass part is extracted from a four-track master of a performance from Göteborg, Sweden 1974 [...] A year and a half later, the bass track was peeled off the Swedish master and transferred to one track of another studio 24-track master for a slow song in 11/4. [...] All of the sensitive, interesting interplay between the bass and drums never actually happened...[62]

Watson draws a parallel with serialism – like serialism, xenochronicity uses predetermined elements to generate chance events – but he then contradicts himself by declaring it "utterly random". The keyword is "generate"; xenochronicity is not a chance process, but it does produce unpredictability. It works by mapping one recording on to another of no relation. The alignment of the recordings, decided by Zappa, determines the perceived interplay between the instruments, therefore the probable outcomes of combining two recordings are fixed from the start. The only part of the process that can be randomised is the alignment, which determines how recordings are superimposed – but Zappa does not do this. Even so, the track "Rubber Shirt" is fairly unpredictable, in spite of the high degree of control and relatively little randomness involved in the process; however, one must take into account

58 Sleevenote to "Rubber Shirt", *Shiek Yerbouti*, 1979.
59 Sleevenote to *Shut Up 'N Play Yer Guitar*, 1981.
60 Frank Zappa, "Friendly Little Finger", *Zoot Allures*, 1976.
61 Watson, Ben, *Frank Zappa: The Negative Dialectics of Poodle Play*, Quartet Books, London, 1993, p. 303.
62 Sleevenote to "Rubber Shirt", *Shiek Yerbouti*, 1979.

that the pre-xenochronised recordings have their own degree of perceivable unpredictability. The process itself may be represented in the following way:

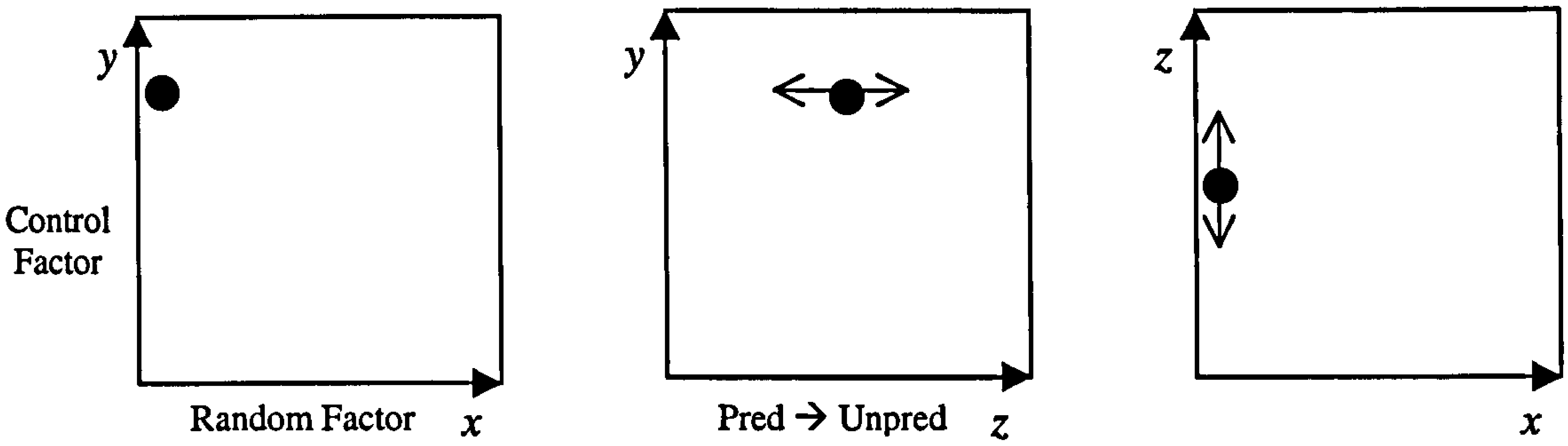

Figure 3-3: Degrees of unpredictability, in process and perception, in the piece "Rubber Shirt"

The *x*-axis shows the amount of randomness involved during the process (which amounts to very little, if any). The *y*-axis shows composer control, i.e., choices regarding which recordings to use and how to align them, and because the recordings used in "Rubber Shirt" are improvised, this cannot be total. In terms of perception, the interplay between instruments is quasirandom, but a sense of order is still detectable, e.g., the fluidity of the bass playing, how certain pitches are central to melodic development. In this instance, a midpoint is appropriate since not every aspect of the track is unpredictable. On *Joe's Garage* (1979), the technique was developed further, but had less to do with quasirandom generation, more to do with practicality:

> I came back with a stereo Nagra tape of just guitar solos and thought of songs where they could go. You try to find something that's in the same key but the time signature could be different. In "Packard Goose" the backing is in 4/4 and the solo was played in 15/16 in a totally different tempo.[63]

[63] Ibid., p. 366, citing an article by Paul Colbert, "Frank Zappa", *Musicians Only*, 26 January 1980, p. 15. It should also be noted that Conlon Nancarrow (of whom Zappa was a fan) possibly provided the inspiration behind the use of multiple simultaneous tempos. In Study No. 22, one of Nancarrow's canons, each of the three voices undergo changes in tempo of 1%, 1.5% and 2.25%. Zappa later explored this in Synclavier pieces like "Beat The Reaper" from *Civilization Phaze III*, 1994.

3.2.3 The Synclavier

In the mid 1980s, after many years and much money spent trying to goad musicians into accurately performing his compositions, technology came up with an answer. The technology in question was New England Digital's Synclavier and with it, Zappa was able to pursue his interest in complex rhythmic groupings, no longer restricted by human limitations. So delighted was Zappa with his new purchase, he almost went as far as saying he did not need musicians anymore because he had bought a "machine" that could perform his compositions with precision, repeatedly and without getting bored.[64] When asked in 1987 if he preferred working with a machine or musicians he responded, "With a machine. No question. No contest"[65] but by 1988 this response had mellowed to, "I must admit, from time to time I'm almost tempted by the 'human element'".[66]

The Synclavier was developed over a number of years, starting life as the first commercially successful 8-bit FM/additive synthesizer in the 1970s and ending up as the first computer workstation capable of sampling, sequencing, sound manipulation and scoring, by the late 1980s. Early models were unusual in that they could be operated with a visual display unit, allowing users to see exactly what they were programming. This was ideal, since the most important aspect of the Synclavier was the incredible degree of control it offered over musical parameters. By 1984 it had integrated a primitive form of mono sampling into its workings, the quality of which improved over the following years with the addition of a computer and direct to disk recording to allow stereo sampling.

The first album of Zappa's music to be composed and realised on the Synclavier (with the exception of a guitar solo) was *Jazz From Hell* (1986), although prior to this, it had been used to a lesser extent on *The Perfect Stranger* (1984), *Thing-Fish* (1984), *Francesco Zappa* (1984) and *Frank Zappa Meets the Mothers of Prevention* (1985). Zappa worked on

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[64] Zappa, Frank with Occhiogrosso, Peter, *The Real Frank Zappa Book*, Picador, London, 1989, p. 173.
[65] Watson, Ben, *Frank Zappa: The Negative Dialectics of Poodle Play*, Quartet Books, London, 1993, p. 459.
[66] Zappa, Frank with Occhiogrosso, Peter, *The Real Frank Zappa Book*, Picador, London, 1989, p. 173.

Jazz From Hell for eight months. The downside of using a computer was the amount of time taken up inputting data; and unlike musicians, the Synclavier could not improvise and had no personality.[67]

There were three ways of typing in information, a) using the programmable language *Script*, b) a music printing program or c) the G Page. Zappa preferred to use methods 'b' and 'c'. The G Page displayed three tracks, each with three editable columns of information representing note start time, pitch/octave and duration. The Synclavier could also be played into directly by way of electronic drum pads or the Synclavier's touch sensitive keyboard. Drum pads were especially useful for generating streams of notes with various dynamics. Rhythms played in inaccurately could be quantised (e.g., to the nearest semiquaver or demisemiquaver) by way of the *resolution factor* facility or by editing start times in the G Page. Zappa also experimented with guitar-based input devices but his technique caused them to falsely trigger.

> The Roland electronics won't read things like hammering on the string with a pick; it just chokes on that. The way in which I finger the instrument apparently is too slovenly for it to read. [...] You can adjust the sensitivity with certain parameters, but if you adjust the sensitivity higher, that means it's going to pick up fewer nuances – so where do you draw the line?[68]

Another problem was the awkward delay between plucking a string and hearing the result.[69] For the composer seeking high levels of control, these uncertainties proved problematic. When it was eventually released, critics complained that *Jazz From Hell* lacked "the human element",[70] but despite this, it won Zappa a Grammy Award.

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67 "Machines don't decide to say things like "We're Beatrice" in precisely the "wrong" place in the middle of a song, and make people laugh". Zappa, Frank with Occhiogrosso, Peter, *The Real Frank Zappa Book*, Picador, London, 1989, p. 173.

68 Forte, Dan, "The Sin in Synclavier", *A Definitive Tribute to Frank Zappa* (from the publishers of Guitar Player and Keyboard), Miller Freeman, Inc., 1995, p. 40.

69 Ibid.

70 The following year Zappa released *London Symphony Orchestra Vol II* (1987), an album filled with human elements (in this context, mistakes). Zappa, Frank with Occhiogrosso, Peter, *The Real Frank Zappa Book*, Picador, London, 1989, p. 155.

3.2.3.1 "The Girl in the Magnesium Dress"

The Perfect Stranger featured the Ensemble Intercontemporain, conducted by Pierre Boulez, performing Zappa's orchestral music. It also contained several Synclavier pieces including "The Girl in the Magnesium Dress". This piece used G numbers: numerical instructions (sometimes referred to as "dust") produced by a guitar controller. G numbers described to the Synclavier how the guitar strings were being played. Since Zappa declared he did not use guitar controllers because of the high error rate, "Magnesium Dress" appears to have been a one-off experiment, turning a negative experience into a positive one: falsely triggered G numbers, produced by Zappa's self-proclaimed "slovenly" technique, became the foundation for a composition.

> There's subterranean information, which can only be viewed when you go out of the user-friendly part of the machine and into the mysterious world of XPL programming. [...] If you plugged in a guitar [...] besides recording the note you play, it records a bunch of data in the form of G numbers. [...] We found a way to convert bunches of G numbers into note blanks. And G numbers occupy points in time. So what I did was take the rhythm of the dust and impose pitch data.[71]

In terms of pitch and rhythm, this method of composing is the opposite of that used in "Approximate"; here, the rhythms are unpredictable and the pitches composed. Rhythm is based upon the unintentional generation of undesirable data. *Figure 3-4* shows the three-dimensional representation of "Magnesium Dress". With Zappa defining the majority of the parameters, the level of control (y-axis) is relatively high, so too is the amount of randomness (x-axis), with the rhythmical aspect arrived at by accident. Zappa's choices of pitch are also quite unpredictable; although a general contour is detectable, it is not obvious by any means. For this reason, the piece may be perceived as containing both randomness and order, with a stronger tendency towards randomness.

[71] Menn, Don, "Belgian Waffles in Plastic", *A Definitive Tribute to Frank Zappa* (from the publishers of Guitar Player and Keyboard), Miller Freeman, Inc., 1995, pp. 84-85.

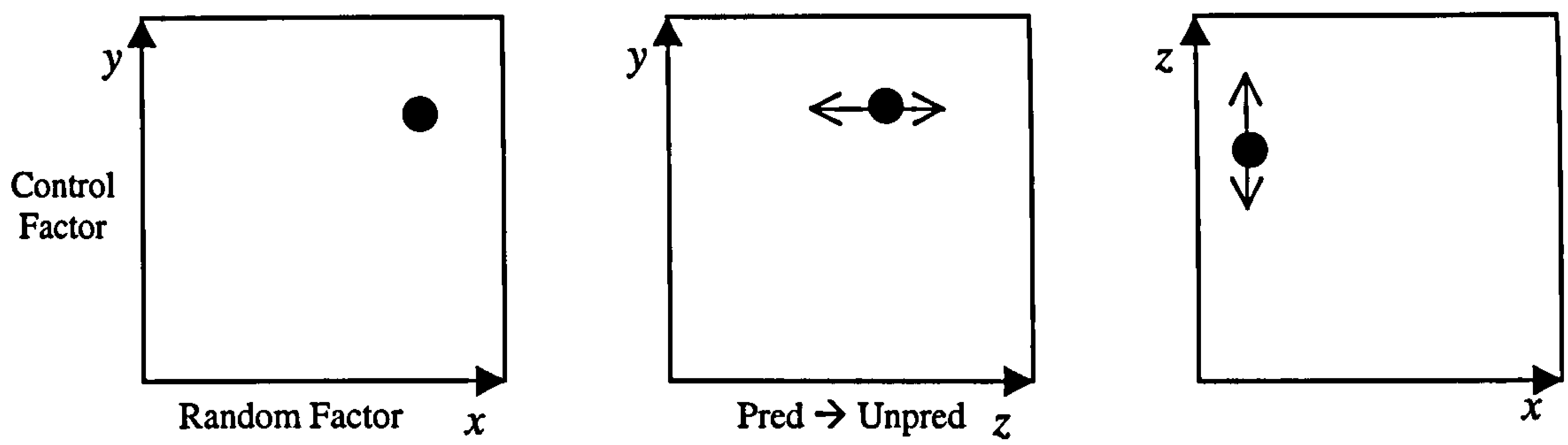

Figure 3-3: Degrees of unpredictability, in process and perception, in "The Girl in the Magnesium Dress"

According to Kevin Courrier, "Magnesium Dress" contains a "steady stream of notes" reminiscent of Nancarrow's work.[72] Equally applicable is Boulez's work *Répons* (1981-84), which at times uses similar electronic percussive timbres and streams of notes.

3.2.3.2 Regaining the Human Element

As computer memory became larger and more affordable, ways of reintroducing the human element into the music through the use of high quality stereo samples and the improved expressive capabilities of the Synclavier became a major focus. In many respects, it allowed Zappa to continue his exploration of musique concrète, but in a digital domain. Zappa created banks of industrial sounds and instrument samples, sourcing material from field recordings, his own master tapes, and from the musicians he was working with at the time. During rehearsals for the Yellow Shark concert series, Zappa sampled each musician of The Ensemble Modern, playing the range of their instrument at different attack rates, for use in his Synclavier pieces. He was nonetheless aware of the limitations:

> You can put vibrato on it and change its amplitude and change its duration, but basically it's a digital recording of some event. [...] If you have a really fine clarinet player, every one of

[72] Courrier, Kevin, *Dangerous Kitchen: The Subversive World of Zappa*, EWC Press, Toronto, 2002, p. 389.

> the notes that he played would be different, and your ears detect that variety. I think the ear prefers variety [...][73]

One of the methods developed to overcome this lack of variety was to create imaginary instruments out of several different instruments, positioning them along the keyboard so that each key played a different instrument pitch/timbre.

> Instead of having a patch that is just saxophone, for example, you can have a patch that is a few notes of the sax, a few notes of a clarinet, a few of an oboe, a few of a trombone, all different instruments, appearing on different notes, all of them on the keyboard.[74]

Zappa freely chose which instruments would sound where on the keyboard and then refined his choices to create subtle note variations as the composition progressed. The technique can be heard clearly on the track "A Pig with Wings".[75] Speaking retrospectively, Spencer Christu, Zappa's engineer, commented that by "recording samples, just titbits, almost one note of every instrument [at] different attacks" Zappa gained the flexibility to compose in "realtime".[76] Other techniques were also developed to put the "human element" into pieces realised on the Synclavier. As with drum machine loops (where the same bass drum and snare drum sounds are repeated), percussion patterns on the Synclavier used the same samples over and over again. Zappa proposed a way around this by using multiple samples of each instrument, so that each snare drum sample would be from a different recording. It is presumed this process would need to be randomised, or occur in such a way as to appear random.

Although Zappa enjoyed the control he achieved with the Synclavier he continued to tour throughout the 1980s. On his final tour in 1988 he took his Synclavier on the road with a twelve-piece jazz/rock band. Emphasis was placed on the advancements made in the

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[73] Menn, Don, "Belgian Waffles in Plastic", A Definitive Tribute to Frank Zappa (from the publishers of Guitar Player and Keyboard), Miller Freeman, Inc., 1995, p. 77.
[74] Forte, Dan, "The Sin in Synclavier", *A Definitive Tribute to Frank Zappa* (from the publishers of Guitar Player and Keyboard), Miller Freeman, Inc., 1995, p. 48.
[75] Frank Zappa, "A Pig With Wings", *Civilization Phaze III*, 1994.
[76] "Frank Zappa: American Composer", A Radio Documentary for "The Music Makers" Series on Public Radio International. http://www.zappa.com/MUSIC/fzac/welcome.htm

Synclavier's sampling technology but Zappa was also experimenting with ways of improvising with it. Albums such as *The Best Banned You Never Heard in Your Life* (1991) show the significant role samples were playing, often appearing unexpectedly throughout songs or in response to a joke or some other spontaneous event, in line with the motto "anything, anytime, anywhere – for no reason at all". Samples also took Zappa's parodying of rock and pop clichés to another level, mimicking their use in rap music, with vocal samples like "check it", and the famous Michael Jackson cry, "ow!"

Almost a year after he died, *Civilization Phaze III* (1994) was finally released. Planned for ten years, it was intended as the sequel to *Lumpy Gravy* and used sections of dialogue recorded inside a piano from the original 1967 sessions. It also introduced a new generation of "piano dwellers". The amount of conversation Zappa could use on Lumpy Gravy was limited by the tape medium; the piano ambience would vanish abruptly at the edit point. A piece of Synclavier software called Sonic Solutions solved this problem and allowed Zappa to manipulate the conversations in ways previously impossible. In the sleeve notes he states that "plot continuity is derived from a serial rotation of randomly chosen words, phrases and concepts, including (but not limited to) motors, pigs, ponies, dark water, nationalism, smoke, music, beer, and various forms of social isolation". How this works (how random was the selection process?), is not clear, but in mentioning serial rotation, comparisons may be drawn with methods of quasirandom generation associated with cryptography (a subject discussed in more detail in Chapter 4), in particular, the Vigenère Cipher (see page 131).

3.3 PROJECT/OBJECT: QUASIRANDOM ORGANISATION

Beginning in late 1964, *Project/Object* was the unifying term Zappa coined to describe his own creative output. Consequently, Project/Object was a work in progress. Each album was another step along the way.[77] Zappa understood the different elements of his work in relationship to a whole. All the bits of the cultural debris associated with being in a rock band were embroidered into the fabric of Project/Object. The connecting material, the way future albums, movies, album sleeves and interviews would cross-reference each other, became known as "conceptual continuity". Even today, the process of seeking out continuity clues causes some fans to commit a great deal of obsessive behaviour. As Watson states, each time Zappa was asked about some "puzzling" feature which might reveal some hidden truth, a new set of questions would occur serving to complicate matters further.

Melodies, words and images treated this way take on a greater importance. As themes reoccur and entwine, a web of "obscure complexity" (see page 25) is created. This explains why first-time listeners to Zappa's music often find it alienating. The web of connections helps Zappa achieve his own kind of surrealism. New relationships are formed between materials taken from one context and used in another. Without prior knowledge of the original context, the listener compensates for what is missing. This causes disruptions in the logical flow of events, resulting in a series of apparently irrational juxtapositions, which only begin to make sense through investigation of the works, a process of unravelling the layers of encryption to reveal the original meaning.

Zappa's body of work takes on an open form with listeners free to choose the order in which albums are experienced. This is true for any artist, but in Zappa's case it is potent for it dictates how the thematic elements are presented to the listener over time. The process of selection is linked to decisions made by consumers at the point they choose to buy a particular album. Few people today go out and purchase Zappa's records in chronological order. Fans of hard rock might seek out the albums featuring Aynsley Dunbar or Steve Vai (who were both members of Whitesnake in the 1980s), jazz fans might wish to hear those albums featuring George Duke or Jean Luc Ponty, blues fans might choose the albums featuring Johnny "Guitar" Watson or Sugar Cane Harris. The decision

[77] In accordance with the *200 Motels* press kit, circa 1971.

to purchase might be based on a number of non-musical reasons (price, availability and sleeve design) as well as musical ones (the desire to hear a particular song). Because of "conceptual continuity", these decisions have a bearing on how Zappa's music is perceived.

3.3.1 Thematic Links

The impenetrability of "conceptual continuity" is a matter of perception. It can be considered cryptic because it presents listeners with incomplete information, but Zappa was not applying encryption techniques in the manner of any normal cryptographer. The case could be argued that "conceptual continuity" is closer to "steganography". In steganography the existence of information is hidden (e.g., a document may be written in disappearing ink), rather than the meaning of the information, as is the case in cryptography (e.g., a document undergoes encryption); however, to describe "conceptual continuity" as steganographic is not entirely accurate either because the information is not really hidden – it is merely located elsewhere. Probably the best way of conceiving "conceptual continuity" is to compare the structure it forms with the type of quasirandomness described by cryptographers as "obscure complexity". All the clues are present but the patterns are so complex and intricate that the end result may be perceived to be random. For example, in the 1982 live version of "Approximate" as featured on *Stage IV*, members of the group replaced parts of the score with the following vocal lines:

(1) Heinz, Heinz...
(2) Make food.
(3) Ah-Oh-Eh-Ah...(Ieee!)
(4) Dagmar, Din-din!
(5) Stayin' alive - Ah, ah, ah, ah
(6) There's a '39 Buick blocking the driveway.[78]

To the occasional listener of Zappa's music, this most likely reads as six lines of postmodern, deconstructed irrelevance, when in truth, each line is packed with cross-

[78] Frank Zappa, "Approximate", *You Can't Do That On Stage Anymore, Vol. IV*, 1988.

references and themes relevant elsewhere. Watson makes a valid argument for Zappa the modernist by raising this point.

> Conceptual continuity may well serve as a term for an underlying substratum of associations that anyone uses over the years in order to express themselves – the network of meanings revealed, say, in Samuel Taylor Coleridge's notebooks, which show irrational attachment to words that appear at key points in his poems – but what makes Zappa's use of it modernist is that he brings this substratum to consciousness.[79]

It is difficult to assess the spontaneity of the vocal lines without comparison to other performances from around the same time, none of which are currently available. In later versions of "Approximate" the music sounds increasingly "fixed"; it is tempting to assume that the same applies to these lyrics. This theory is backed up by a copy of the score provided by Barrow, showing in his own handwriting the word "cornhole" written in pencil above the music. However, changing the words to songs was extremely common during live concerts, as is well documented on Zappa's many live releases.

But Zappa was not simply fixing the infinite; he was applying the principal of cryptography, aiming to disguise a message behind a smokescreen of nonsense. Each line of lyric acts as a conceptual trigger. Bottles of Heinz Tomato Ketchup [1] conspicuously made their way onto the front of two albums in 1984, *Them or Us* and *The Perfect Stranger* by way of Donald Roller Wilson's artwork. The word "ketchup" can be traced to "San Ber'dino" and "When The Lie's So Big". It can also be grouped with references to condiments in general, for example on *Broadway the Hardway* (1988) "The Untouchables" ("You're baloney without the mayo, buddy!"). The theme of making/preparing food [2] is common in Zappa; some examples occur in *200 Motels* (1971) "Sealed Tuna Sandwich" ("This town is just a sealed tuna sandwich with the wrapper loose"), *Joe's Garage* (1979) "Crew Slut" ("add water, makes its own sauce"), *Broadway the Hardway*, "Why don't you like me" ("Make me a sandwich!"). "Dagmar" [4] appears for the first time on *Sheik Yerbouti* as the drag queen at The Grape nightclub in "Broken Hearts Are For Assholes". By 1982, "Stayin' Alive" [5] by the Bee Gees was assimilated into "Approximate"; the

[79] Watson, Ben, *Frank Zappa: The Negative Dialectics of Poodle Play*, Quartet Books, London, 1993, p. 229.

inclusion of a line from such a rhythmically simple song, in such a rhythmically complicated one, emanates from Zappa's humour. The final line [6] is connected to an uncharacteristically banal moment during a Mothers of Invention concert in 1969, when Zappa announced to the audience that a Chevrolet parked outside needed to be moved. This highly obscure piece of information was revealed earlier in the *Stage* series.[80]

3.3.2 "Conceptual Continuity" as Thematic Cryptography

"Conceptual continuity" can be conceived as a jigsaw puzzle waiting to be solved. The pieces by themselves seem inconclusive if not viewed as part of the whole picture. It can also be viewed as an analytical process; by tracing internal thematic interconnectivity, it is possible to gain a greater insight into Zappa's art.

This final section attempts to show how an album cover can be the trigger for waves of "conceptual continuity", tracing themes as and when they occur on the material surface in an attempt to uncover the "true meaning" through deeper penetration. This explains the use of the word "cryptography" in the title of this section, since to solve "conceptual continuity" it is necessary to seek out recurring patterns, similar to the way hackers try to find seed or key values to decrypt a message. In the booklet accompanying the *Stage* series of CDs, Zappa refers to "continuity clues", suggesting that answers to previously unexplained aspects of his oeuvre might be found within.

3.3.2.1 A Reading of "Conceptual Continuity": *The Grand Wazoo*

After Zappa disbanded the first incarnation of The Mothers in 1969, he began working with a 20-piece jazz/rock orchestra. Much to the dismay of Mothers fans, the rock'n'roll, Dada humour and controversial social commentary was absent. Instead, Zappa stood at the front

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[80] Frank Zappa, "Louie Louie", *You Can't Do That On Stage Anymore, Vol. I*, 1988.

of the group and conducted, while the musicians sat on their chairs and read the music. This new band was called The Grand Wazoo Orchestra. Some of the music from this period was released on *Waka Jawaka (Hot Rats II)* (1971) and *The Grand Wazoo* (1972). The latter's sleeve design features a battle scene set in ancient Rome, but Zappa's concept of time as a spherical constant, where everything coexists at the same time, means this is no ordinary battle. Against the backdrop of a crumbling Roman coliseum, and what appears to be a huge monument engraved "The Grand Wazoo", a jazz/rock horn section (consisting of Norman soldiers and Egyptian pharaohs) fights off an army of Roman violinists. Instead of gunfire, they exchange hostile notes. The winged emblem across the top of the monument recalls the eagle symbol of the Holy Roman Empire, an icon much associated with Nazi Germany. The battle scene recalls the "traditional" verses the "modern" discourse of The Mothers' stage play "Progress"[81] and the fusion of orchestral and rock music of *200 Motels* (1971). Alongside the music of *The Grand Wazoo* album, Zappa provides the listener with some reading material: "The Legend of Cletus Awreetus-Awrightus and The Grand Wazoo", a typical Zappa nonsense story, parodying the music industry, life on the road and groups trying achieve chart success.

At the time of Grand Wazoo Orchestra's inception, music journalists pondered the meaning of the name.[82] Zappa supplied two options, two decades apart. During the story of Cletus Awreetus-Awrightus, the Grand Wazoo is described as "an oversized primitive-but-effective megaphone" used to address "QUESTIONS".[83] However, in the linear notes to a Synclavier track released twenty-four years later and also called "The Grand Wazoo", Zappa gives it a completely different meaning: "Anybody in any one of those lodge organisations with a stupid hat on – actually the guy with the biggest, dumbest hat is the Grand Wazoo".[84]

[81] Frank Zappa, "Progress", *Ahead Of Their Time,* 1993.
[82] Siders, Harvey, "Meet the Grand Wazoo", *Downbeat 9/11/72.* "It's a typical "Zappelation," made up of one part gibberish, one part satire, and the rest--just plain old put-on".
[83] This recalls Charles Ives' "The Unanswered Question". In commentary relating to the piece, Ives outlined the symbolism of its parts which included a solo trumpet asking "The Perennial Question of Existence". http://www.musicweb-international.com/Ives/WK_Unanswered_Question.htm
[84] Frank Zappa, "The Grand Wazoo", *The Lost Episodes*, 1996.

> You may think my hat funny but I don't – I'm the Grand Wazoo; the keeper of the mystic scroll and roll parchment from the lodge. And I'm a Veteran. Every day on coffee break at the hardware store, I tell Fred what to expect because we play pranks during the initiation.[85]

This short piece of text perfectly describes Zappa's relationship with new members of his fan base. Zappa *is* the Grand Wazoo (despite the text having been read by Captain Beefheart) and the concert arena is the lodge. The band make up the experienced members of the lodge since they regularly take part in the band rituals (rehearsals, gigs, tours, groupies) and the audience is characterised by Fred – always aware to expect the unexpected at a Zappa concert. The secrecy surrounding lodge organisations, their dependence on ritual ceremony, pledges of allegiance and secret handshakes, induces paranoia in the outsider and a sense of comradeship amongst those within. The Grand Wazoo's big, stupid hat may be a symbol of his status,[86] but it is a symbol understood and respected only by those privileged enough to join the lodge.

The Grand Wazoo works at a hardware store. In reality, clandestine organisations represent a cross-section of society, from ordinary members of the public to those in positions of power such as politicians and the police – the figures of authority Zappa targeted on *Absolutely Free* and *We're Only in it for the Money.* The lodge is amusing to Zappa because it exchanges one set of lifestyle codes – the restrictive social codes of a moral society – for another equally "unfree" set, those of the secret society. Zappa is exposing the average American's need for escapism from the repressions of the workaday life. But it is the private (often sinister) goings-on, possibly of those conspiring against the interests of the masses, which Zappa is most interested in. His desire to reveal the closely guarded secrets of the state authorities, the decisions made behind the "closed doors" of the boardroom,[87] the record company head office and, of course, the bedroom, are well represented in his body of work.

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[85] Frank Zappa, "The Grand Wazoo", *The Lost Episodes,* 1996.

[86] Zappa occasionally wore funny hats as distancing tool to prevent others taking him too seriously. There is a famous 1970s photograph of Zappa wearing a dunce's hat.

[87] Frank Zappa, "Cocaine Decisions", *The Man From Utopia,* 1983.

Nothing is more paranoia inducing than the knowledge that someone is being secretive. The secret whispers heard by the jock in "Status Back, Baby",[88] the secret underground dumps (where they keep the pools of old poison gas, and obsolete germ bombs) in "Billy the Mountain".[89] During live concerts, Zappa would often announce, "The secret word for tonight is...". The secret word could be anything. In a concert from 1988 it was "Ring of Fire" due to a chance meeting with Johnny Cash earlier that day. The album *Fillmore East, June 1971* features the secret word "Mudshark", after the exploits of rock stars with marine life at the Edgewater Inn. The secret word could also be a sound, as on *The Yellow Shark*, which features the Ensemble Modern firing toy ray guns upon Zappa's cue. Secret words at concerts and the Grand Wazoo's stupid hat at lodge meetings are both codes, the significance of which is only understood by those present at the time, indoctrinated into the proceedings. The cryptic nature of "conceptual continuity" poses problems to the uninitiated in a similar way.

3.4 SUMMARY: MOVING BEYOND ZAPPA

The range of techniques used by Zappa to achieve elements of unpredictability was very diverse, incorporating amongst other things, improvisation strategies (e.g., conduction and indeterminacy), and studio techniques (e.g., xenochronicity and random data generated by a guitar controller). They may also be linked to the social climate of the time (i.e., 1960s-70s), which was (to some extent) more open to experimentalism in popular music than may be the case today.

One of the more important aspects raised by this chapter relates to the perception of unpredictability, especially in relation to the way the components of Zappa's Project/Object

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[88] Frank Zappa, "Status Back Baby", *Absolutely Free,* 1968.
[89] Frank Zappa, "Billy The Mountain", *Just Another Band From L.A.*, 1972.

(the albums, movies, interviews and books) cross-reference each other. Through "conceptual continuity", his oeuvre offers an ordered thematic complexity between individual components, which, when isolated from each other, may be perceived as highly unpredictable. In essence, his surrealism is cryptic; clues are offered, but the key to unlocking their meaning is hidden elsewhere, usually on another record. With only part of the information available to form a whole picture, the listener may experience elements of unpredictability. Only through a process of further investigation and contextualisation can the complete meaning be extracted.

The cryptic nature of Zappa's work suggests that an understanding of cryptography might offer new directions musically. Encrypted messages, after all, usually appear random. The following chapter sets out to establish a better understanding of cryptography. Through formalised methods, the possibility of utilising the quasirandom qualities of encryption algorithms in music is explored. Boulez, who opposed the use of chance in composition, emerges as an unlikely counterpart in developing new techniques.

CHAPTER 4

PRN GENERATION AND THE APPLICATION OF ENCRYPTION

This chapter is divided into three main sections and a summary, and investigates ways of achieving quasirandomness (complex order perceived as randomness). It aims to show how PRN generation may be incorporated into experimental processes designed to introduce unpredictability into popular music. Central to this debate is the idea that some encryption techniques operate similarly to PRN generators. Section 4.1 presents the subject of cryptography as a deterministic means of attaining quasirandomness. It explains the associated terminology and offers examples of a variety of ciphers, as well as musical encryption. Section 4.2 investigates the similarities between the Vigenère Cipher (a polyalphabetic cipher) and Boulez's *Structures 1a,* arguing that both achieve unpredictability because they are based on principles closely associated with basic PRN generation. In section 4.3, cryptographic and serial techniques are united in a series of experiments which further explore PRN generation within music.

Cryptography may seem to have little in common with composition, but a number of comparisons can be made. Both disciplines are associated with the organisation of materials (letters, numbers and symbols, in case of cryptography; sounds and silences, in the case of music) and the degree to which this organisation results in recognisable and predictable patterns.[1] Section 4.1 begins by explaining the principles of cryptography, with references to Monoalphabetic Substitution Ciphers; section 4.1.1 looks into some of the

[1] For example, simple encryption techniques, such as Caeser Ciphers and Simple Substitution Ciphers, affect the letters of a word in much the same way as transposition affects the pitches of a melody. Also, Polyalphabetic Ciphers encrypt words by evening out the relative expected frequencies of letters; similarly, twelve-tone music often sounds keyless because, in theory, all the pitches are equally distributed throughout.

techniques used to secure information across digital networks, e.g., Markov Ciphers. In section 4.1.2, musical encryption is discussed. Composers have been embedding hidden messages within music for centuries, but rather than use encryption techniques to create quasirandomness, the objective has usually been to maintain a sense of order over the material so that it does not sound unpredictable. Some historical examples of musical encryption are provided, focusing on Alban Berg's serial work *The Lyric Suite* (1926).

Section 4.2 investigates a polyalphabetic cipher known as the Vigenère Cipher and compares it to the composition process used by Boulez to create *Structures 1a*. It is shown how both work along similar lines, generating quasirandom material from systems based upon similarly constructed matrices. It supports the idea that, although Boulez was against leaving compositions entirely to chance, he was interested in unpredictability.

In section 4.3, serial and cryptographic procedures are combined in a series of compositions, exploring ways in which PRN generation can be incorporated into experimental popular music. Although most of these experiments do not actually encrypt anything (the exception being the final one) common procedures associated with encryption are used (e.g., displacements and transpositions) to generate quasirandom patterns. A system based upon binary grids is introduced as the means of generating quasirandomness from small random pitch sequences acting as seeds. Each of the first three experiments uses a binary grid to determine rhythm and structure. Experiment I (section 4.3.1) assigns quasirandom pitches, determined by a binary grid, to these rhythms. In section 4.3.2, pitch sets, again defined by a binary grid, are randomised and mapped on to quasirandom rhythms. The effects of using different seed values within this system are explored in section 4.3.3. The final experiment, described in section 4.3.4, carries out a range of encryption techniques on the pitches and durations of a melody by The Beatles. Throughout this chapter, reference is made to musical examples contained on *CD 1*.

4.1 CRYPTOGRAPHY

Cryptography is generally regarded to be a subject area outside of music, with its own terminology. Clarification is provided here to support the following sections. Cryptography is the study of ciphering techniques which are used to conceal data, usually referred to as "plaintext", from an interceptor. Encryption is the procedure of concealing the plaintext, where the encrypted plaintext is called the "ciphertext" (or "cryptogram") and the set of rules that govern encryption is called the "encryption algorithm". The operation of the encryption algorithm depends on a seed value or "encryption key", usually inputted alongside the plaintext by the message sender. More effort usually goes into the protection of the encryption key than to the actual cipher, since it is a basic assumption in cryptography that an adversary will have the technology to intercept a message and identify which encryption algorithm has been used. This means that a "decryption key" is required by the message receiver in order for the original plaintext message to be revealed.[2]

The role of encryption/decryption keys may be made clearer by explaining a Caesar Cipher. This is a very simple Monoalphabetic Cipher, which uses displacement (or a shift) to encrypt a message. It is also an example of a Simple Substitution Cipher.

```
Plain Alphabet:    ABCDEFGHIJKLMNOPQRSTUVWXYZ
Cipher Alphabet:   UVWXYZABCDEFGHIJKLMNOPQRST
```

Figure 4-1: Caesar Cipher

The displaced alphabet is offset against the regular alphabet by a shift of, in this case, six.[3] It follows that "six" is the value of the encryption key and decryption key. Exchanging letters in the regular alphabet with those in the displaced alphabet encodes the words. For

[2] Piper, Fred and Murphy, Sean, *Cryptography: A Very Short Introduction*, Oxford University Press, Oxford, 2002, pp. 7-8.
[3] If there is no displacement, it is described as a shift of zero.

example, the word RANDOMNESS becomes LUHXIGHYMM. It is worth noting that early musical uses of cryptography did not moved far beyond methods of substitution similar to this, with composers hiding words (frequently the names of people important to them) by assigning letters to pitches, and then composing as they would normally. Another characteristic of early musical encryptions is that they tend to be perceived as ordered, whereas even a simple encryption such as LUHXIGHYMM might appear random.

The degree of randomness[4] is an important aspect of encryptions, determining how difficult they will be to decipher. When cryptographers discuss the strength of an encryption they are indirectly remarking on how random it appears; the degree of randomness of an encryption is considered a measure of its durability. Tough encryptions do not give way easily because they satisfy two important requirements: diffusion and confusion.[5] The "diffusion property" is one where a small change in the plaintext results in the interceptor experiencing "an unpredictable change in the ciphertext".[6] The "confusion property" implies that an interceptor applying a "brute force" attack (where all possible encryption key values are searched) is given no indication as to when they are near the correct key value.[7] It is unlikely that such stringent measures have contributed to cryptographic music, which attains its level of security by not raising suspicions (i.e., by being a piece of music).

Usually in cryptography, a distinction is made between the degree of randomness of an encryption algorithm, which is essentially a quasirandom operation requiring a key, and the randomness of the key itself, which can be quasirandom or random (see Ellison's definitions of cryptographic randomness on page 25) depending on the security level of information to be encrypted and the amount of time it is exposed to a potential interceptor. The criterion of key generation is that an interceptor has no knowledge of how the key was

[4] This term stems from information theory where the degree of randomness is a quantifiable measure intrinsic to a sequence.
[5] Piper, Fred and Murphy, Sean, *Cryptography: A Very Short Introduction*, Oxford University Press, Oxford, 2002, pp. 66-67.
[6] Ibid. So that, even though the words "difference" and "differences" are almost identical in plaintext, it would be very difficult to find any similarities between their encryptions.
[7] Ibid.

produced. In the case of encryptions that are only exposed for a short time, a quasirandom key is usually adequate, but the longer an encryption is exposed, the more vulnerable this method becomes.

4.1.1 Modern Ciphers

In recent years, robust cipher systems have rapidly been developed to cope with the growing use of the Internet, e.g., for credit card security. If a pattern is detectable within an encryption it raises the chances of it being completely decrypted. Encryption makes up an essential part of digital communication to such an extent that modern encryption algorithms are designed around binary digits (bits). ASCII (American Standard Code for Information Interchange) is the most commonly used digital encoding method for alphanumeric characters, where each character is represented by an eight-bit binary sequence. There are three common methods of binary encryption, Stream Ciphers, Block Ciphers and Cipher Block Chaining. Each of these contributes to the experimental piece discussed in section 4.3.4.

Stream Ciphers provide a binary representation of the plaintext by way of a "bit-by-bit" encryption. Since there are only two states at this level (1 and 0), the only type of encryption that can take place involves either changing a bit or leaving it unchanged. A keystream is used to encrypt the plaintext by way of applying Exclusive OR (written XOR or ⊕) to each bit. This is equivalent to changing only those bits of the plaintext that correspond to 1 in the keystream.

		XOR
0	0	0
0	1	1
1	0	1
1	1	0

```
Plaintext:      01101101
Keystream:      10110110

Cryptogram:     11011011
```

Figure 4-2: Binary encryption based on XOR

One way of creating a keystream is to start with a 4-bit sequence and then apply XOR to the first and last bits of that sequence to generate a fifth bit. Then, by XOR-ing the second bit and the fifth bit, it is possible to create a sixth bit. If this procedure is repeated again and again, a fifteen-bit keystream can be generated – any longer and it will repeat itself. For example, 1001 generates 100100011110101.

Block Ciphers divide the binary representation of the plaintext into blocks of equal length. In ASCII, eight bits represent one character, so an encryption algorithm would act on eight bits at a time. In such a case, a Cipher Block Chain (CBC) or Markov Cipher could be used, so-called because the encryption of a block is dependent on the value of the block that precedes it. Consecutive blocks are XOR-ed together and since there is nothing preceding the first block in the chain, each block is also XOR-ed by an encryption key. A practical example of a Markov Cipher is used in section 4.3.4 to encrypt note duration.

4.1.2 Encryption within Music

Composers are usually drawn to encryption because it presents a challenge: pitches ordered either arithmetically or alphabetically resist forming melodies and phrases in much the same way that encrypted letters resist forming words and sentences; however, a degree of caution is needed when comparing compositions that conceal words to actual processes of encryption. The question mark partially hangs over the composer's intention, i.e., can it be proven that the composer deliberately set out to hide words in a composition? There is always the danger that "if one looks, one will find" and that what one discovers is, in fact, entirely incidental. This is not to say that genuine examples of musical encryption do not exist, simply that the discovery of words in music is not always proof that the composer was intentionally performing an act of encryption. This section offers a handful of examples which use very simple processes of concealment.

Some composers of the Renaissance period, especially Johannes Ockeghem (1410-1497) and his pupil Josquin Desprez (1440-1521) of the Franco-Flemish school, adopted the practice of "gematria", whereby letters would be converted to numbers (e.g., A=1, B=2, etc.), which would be used to determine compositional aspects. William Elders writes that in several of Josquin's compositions:

> [...] The shape of the tenor part, which forms the basis of the music, proves to be dictated by a number which is the sum of a row of figures, each of which signifies a letter. The letters then reveal a name.[8]

In Josquin's Mass, he incorporates a melody of exactly sixty-four notes, which is widely believed to be a tribute to Ockeghem. Applying the Latin alphabet gematrically (where 'i' and 'j' equalled nine, and 'u' and 'v' both equal twenty), O+C+K+E+G+H+E+M=64.[9] Whether or not this is actually an example of musical encryption is debatable. Early historical examples of cryptography in music do exist, but they may more accurately be described as "allusions", i.e., references made indirectly or subtly suggested. Often musical encryptions do not really satisfy the properties of either confusion or diffusion sufficiently for them to count as robust encryption techniques. Also, they may better be described as examples of steganography in that the reason such allusions are hard to find is because their location is hidden amongst all the other notes in the music, rather than because some process of encryption has taken place.

Allusions (highly intentional ones at that) may be found in the work of Robert Schumann. In the first line of his essay "Schumann and the Tonal Analogue" Eric Sams states: "Nearly all Schumann's music contains or derives from words, whether as texts, titles, programmes or epigraphs".[10] Later he explains that to Schumann "words and music are different forms of the same thing".[11]

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[8] Elders, Willem, Composers of the Low Countries, Clarendon Press, Oxford, 1991, p. 79.
[9] Ibid., p. 80.
[10] Sams, Eric, "Schumann and the Tonal Analogue" as printed in Walker, Alan (ed), *Robert Schumann, The Man and His Music*, Barrie and Jenkins, London, 1972, p. 390.
[11] Ibid., p. 391.

> Music can easily (though exceptionally) be assigned a specific denotative meaning, just as words can, and through exactly the same process of spelling and reading letters. If one were unfamiliar with Schumann's Op. 1, but had absolute pitch, then one could read the name ABEGG aloud just from hearing the first five notes of the theme. One would then be reading music in a novel sense but an entirely valid one. Schumann's theme not only means, but says, ABEGG.[12]

Sams is suggesting that Schumann's intentions were not necessarily designed to hide words within music, but rather have the music portray words. Schumann's music is full of such devices, although the extent to which they are detected would vary from listener to listener. Another composer whose music often contained allusions was Berg. Unlike his contemporaries, such as Webern, Berg included more consonant results when using serial techniques, purposefully incorporating a fusion of old and new styles into an individualistic and eclectic approach. He proudly acknowledged that he could conceal a series in a composition so that no one would guess it were there.[13] His methods of manipulating serial techniques gave him scope to integrate autobiographical references into the compositions. Out of the six movements of the *Lyric Suite* (Allegretto, Andante, Allegro, Adagio, Presto and Largo) all but the second is structurally based around the number 23:

Allegretto	69 (3x23) bars
Second subject	23 bars
Allegro	138 (6x23) bars
Trio	23 bars
Adagio appassionato	69 bars
Presto delirando	460 (20x23) bars
Largo desolato	46 (2x23) bars[14]

Figure 4-3: Use of the number 23 in Berg's Lyric Suite

[12] Ibid., p. 391.
[13] Carner, Mosco, "Alban Berg", Duckworth, London, 1975, p. xv. Comparatively Berg's serial works used more consonant harmonies than his counterparts, which led some to describe him as the Poet of the Atonal (Musical America, 51:18, 28 November 1931, p. 10).
[14] Carner, Mosco, "Alban Berg", Duckworth, London, 1975, p. 110.

It is said that the importance of this number is based on its relationship to the date of Berg's first asthma attack.[15] It could also refer to the "regulation 23" under which he was called into the army; however, it was revealed in 1976 (upon the death of Berg's wife, Helene Nahowski) that references to Berg's long term mistress, Hanna Fuchs-Robettin, are also present in the *Lyric Suite*. Keith Shadwick writes: "Both their fate numbers' – his was 23, hers 10 – governed the formal dimensions of the six movements and their initials – AB and HF – determined much of the inner musical arguments. Subsidiary themes were allotted to Hanna's two children, and one line alludes to her husband. Truly this was to be an opera without words."[16]

Another piece, the *Chamber Concerto,* begins with the names of Arnold **Schönberg**, Anton **Webern** and **Alban Berg** encrypted into the opening five bar "Motto". Berg uses letters that correspond to the German notation system (indicated above in bold type, where S=German *Es* or E-flat and H=German B-natural).[17] He arrives at the following (accidentals only apply to notes they are next to):

A, D, Eb, C, B, Bb, E, G   A, E, Bb, E   A, Bb, A, Bb, E, G

Figure 4-4: Pitches of the five bar "Motto"

After this introduction, the main "Thema scherzoso" begins, prefixing the Arnold Schönberg configuration with the four missing pitches to create a twelve-note series which is used in its original, retrograde, inversion and retrograde-inversion forms throughout the section:

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[15] There is some discrepancy about the exact year. Reich ("Alban Berg", London, 1965, p. 26) and Grun (the editor of the English version of Berg's "Letter's to his wife", London, 1971, footnote to letter 21) decide upon 23 July 1908, whereas Redlich ("Alban Berg", London, 1957, p. 294) and Heinsheimer (in Reich, "Bildnis im Wort", Zurich, 1959) gives it as 23 July 1900.

[16] Taken form the CD booklet notes to The Duke Quartet's release of the *Lyric Suite*, 1997.

[17] Boulez used a very similar method of encryption in *Messagesquisse* (1976) which he composed as a seventieth birthday tribute to the Swizz conductor Paul Sacher. Alongside the German notation, Boulez includes R=French *Re* or D to spell out SACHER.

Original: F, Gb, Ab, Db + A, D, Eb, C, B, Bb, E, G

Figure 4-5: Series of the "Thema scherzoso"

What is most striking about Berg's approach is how it compares to a quasirandom method of generating an encryption key, commonly used in Simple Substitution Ciphers. In pre-computer days, the key was often constructed from a memorable expression to prevent it from being forgotten. For example, by removing letter repetition, the sentence "random numbers are very hard to predict" becomes r, a, n, d, o, m, u, b, e, s, v, y, h, t, p, i, c. The remaining letters of the alphabet would then be added to the end of this, with the plaintext encrypted by substituting the letters of the alphabet for those in the key, e.g., the word RANDOMNESS becomes FRTDPHTOGG. This kind of encryption still displays patterns of repeated letters, with the letters 'N' and 'S' substituted for 'T' and 'G', but it is a slight improvement on the Caesar Cipher.

```
Plain Alphabet:     ABCDEFGHIJKLMNOPQRSTUVWXYZ
           Key:     RANDOMUBESVYHTPICFGJKLQWXZ
```

Figure 4-6: Simple Substitution Cipher utilising a quasirandom key

4.2 CRYPTOGRAPHIC RANDOMNESS AND SERIAL ORGANISATION

The following sections demonstrate the similarities between the Vigenère Cipher, a polyalphabetic cipher based on the rotation of alphabets, and Boulez's *Structures 1a*, which organises the parameters of music by way of matrices constructed from the rotation of a transposed series. The non-equivalence present in his serial technique strengthens the quasirandom properties of the music because the many stages required to resolve non-equivalence make it more difficult to detect the system of composition.

4.2.1 Polyalphabetic Ciphers: The Vigenère Cipher

In terms of security, Monoalphabetic Substitution Ciphers are easily cracked providing two conditions are met; a) there is enough of a cryptogram to analyse, and b) the language of the plaintext is known. Although there are 26! (26x25x24x...x2) ways to arrange the letters of the alphabet to form a key, the plaintext may still be detectable from a statistical approach by way of the relative expected frequencies of letters.[18] Polyalphabetic Ciphers are less likely to be decrypted using this method because they even out the rate at which letters occur and, in doing so, appear more random. Consequently, the application of relative expected frequency data becomes a less reliable way of solving the ciphertext.

Simple Monoalphabetic Substitution Ciphers were made redundant with the development of frequency analysis[19] and by the end of the 16th century a more secure system of encryption had been developed. This was called the Vigenère Cipher, the blueprints of which date back to the 1460's, when the polymath Leon Battista Alberti anticipated a cipher based on two or more cipher alphabets.

```
Alphabet:            ABCDEFGHIJKLMNOPQRSTUVWXYZ
Cipher Alphabet 1:   PQOWIEURYTLAKDJSHFGZMXNCBV
Cipher Alphabet 2:   UIKLOZAQWSXFVBGTYHCDERNMJP
```

Figure 4-7: The Alberti Cipher

Alberti's cipher, the first Polyalphabetic Cipher, switched between each cipher alphabet for each letter of the plaintext. This reduced the chances of an attack by frequency analysis

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[18] In the English language, the most frequently used letter is E (12.7%). If E is substituted for O in a cryptogram, then its relative expected frequency also applies to O. A hacker will look for the most common letter in the cryptogram and deduce that it represents the letter E in the plaintext.

[19] During the 16th century, Thomas Phelippes, Europe's best cryptoanalyst, was asked to decrypt intercepted ciphertexts between the imprisoned Mary Queen of Scots and Anthony Babington, her outside supporter. Phelippes successfully unravelled the ciphertexts using frequency analysis and uncovered a plot to break the Queen out of prison, implicating her involvement. The events highlighted a weakness in monoalphabetic ciphers, culminating with the Queen's beheading on 8 February 1587.

since words with consecutive identical letters would not show up in the cryptogram. For example, using the cipher alphabets shown in *figure 4-7* to encrypt the word NUTTY, the 'N' is encrypted using Cipher Alphabet 1 to produce a 'D'; the 'U' is encrypted using Cipher Alphabet 2 to give an 'E'; Cipher Alphabet 1 is used to encrypted the first 'T', resulting in a 'Z'; Cipher Alphabet 2 is used to encrypted the second 'T', to give a 'D'. The completed cryptogram reads SYZDJ. Not only is the presence of identical, consecutive letters in the plaintext disguised (both 'Z' and 'D' represent 'T'), but also letters which are not the same in the plaintext can appear the same in the ciphertext.

```
Keyword:       FLYERFLYERFLYERFLYER
Plaintext:     THISISPOLYALPHABETIC
Ciphertext:    YSGWZXAMPPFWNLRGRRMT
```

Figure 4-8: The Vigenère Cipher

	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	q	r	s	t	u	v	w	x	y	z
1	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
2	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	A
3	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	A	B
4	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	A	B	C
5	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	A	B	C	D
6	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	A	B	C	D	E
7	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	A	B	C	D	E	F
8	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	A	B	C	D	E	F	G
9	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	A	B	C	D	E	F	G	H
10	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	A	B	C	D	E	F	G	H	I
11	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	A	B	C	D	E	F	G	H	I	J
12	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	A	B	C	D	E	F	G	H	I	J	K
13	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	A	B	C	D	E	F	G	H	I	J	K	L
14	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	A	B	C	D	E	F	G	H	I	J	K	L	M
15	O	P	Q	R	S	T	U	V	W	X	Y	Z	A	B	C	D	E	F	G	H	I	J	K	L	M	N
16	P	Q	R	S	T	U	V	W	X	Y	Z	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
17	Q	R	S	T	U	V	W	X	Y	Z	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
18	R	S	T	U	V	W	X	Y	Z	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
19	S	T	U	V	W	X	Y	Z	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
20	T	U	V	W	X	Y	Z	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
21	U	V	W	X	Y	Z	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
22	V	W	X	Y	Z	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U
23	W	X	Y	Z	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V
24	X	Y	Z	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W
25	Y	Z	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X
26	Z	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y

Figure 4-9: The Vigenère Square

Blaise de Vigenère studied Alberti's cipher and made it much stronger by employing 26 cipher alphabets in what became known as the Vigenère Square (*figure 4-9*). Each of the 26 cipher alphabets is a Caesar Cipher, with a displacement to the left one greater than the cipher alphabet directly above it. A keyword is used to determine which of the 26 cipher alphabets is used in the encryption: the longer the keyword, the stronger the encryption. Each letter of the keyword indicates the first letter of a row in the Vigenère Square. To encrypt 'T' (the first letter of the plaintext in *figure 4-8*) the letter at the point of interception with the row beginning 'F' and the column 'T' is used. In this case, the cipher letter is 'Y'.

The strength of this cipher is that a letter which appears a number of times in the ciphertext can represent a different letter in the plaintext each time, making frequency analysis extremely difficult. For example, the letter "R", in the ciphertext above, appears three times, representing 'A', 'E' and 'T'. Sometimes, to make it even harder to decrypt, the ciphertext might be written in blocks of equal length so as to disguise word length.

The appearance of the Vigenère Square, with its shifting and rotating alphabets invites further investigation later in the chapter (see section 4.3), where by replacing the alphabet with a musical sequence and performing similar shifts and rotations, it is possible to perform a quasirandomisation of musical material. Other derivative techniques explored later have structural implications, effectively using the layout of binary grids (designed with the Vigenère Square in mind) to build a composition.

4.2.2 A summary of Pierre Boulez's use of matrices in *Structures 1a*

Having viewed the Vigenère Cipher, it becomes clearer why *Structures 1a* may be perceived as random. Since it was composed in 1951, it has undergone considerable analysis, two examples being György Ligeti's highly regarded paper in *Die Reihe* 4, published in 1957, and Reginald Smith Brindle's subsequent analysis (which owes a lot to Ligeti's insight) in *The New Music: The Avant-garde since 1945* (1975). This section provides a summary of the latter. It does not offer a complete analysis, but serves to highlight the similarities between serial and cryptographic methods of creating quasirandomness. *Structures Ia* is an appreciably complex work, using numerical patterns found within matrices to control and organise musical parameters. The score is very challenging to perform since each note's duration is calculated as a multiple of a demisemiquaver. It is especially relevant to this section because it offers a compositional approach to quasirandomness.

Committed to the principle of traditional European art music, where specific sounds are made at specific moments, Boulez strongly opposed the use of chance, but investigations into the techniques employed in *Structures 1a* reveal that his methods of generating parameter data are similar to those used by cryptographers to disguise messages. Like the Vigenère Square, constructed from displaced rows of the alphabet, Boulez's matrices of transposed note sequences appear to generate a similar kind of quasirandomness (see *figure 4-14*). One might deduce from this that Boulez appreciated music that sounded like it might be random but wanted it to be arrived at through deliberate actions; however, unpredictable patterns of numbers do not necessarily translate into unpredictable-sounding music. Transposition did not affect the intervals between each of the notes.

Structures 1a was determined by a twelve note series derived from Division 1 of Messiaen's *Mode de valeurs et d'intensités.*[20] All twelve transpositions of the original series 'O' and other forms (inversion 'I', retrograde 'R' and retrograde inversion 'RI') were used, giving a total of forty-eight series. Boulez incorporated a system of organisation based on "matrices", assigning a numerical value from 1 to 12 to each note of the original series in the following way:

[20] It should be noted that Messiaen wrote *Mode de valeurs* with total organisation in mind, and it serves as a prototype to the ideas later developed, particularly by Boulez and Stockhausen.

Pitch Number	1	2	3	4	5	6	7	8	9	10	11	12
'O'	Eb	D	A	Ab	G	F#	E	C#	C	Bb	F	B

Figure 4-10: Series 'O'

Likewise, an inversion (itself a basic encryption technique) of the original series, centred on Eb, produced the following:

Pitch Number	1	7	3	10	12	9	2	11	6	4	8	5
'I'	Eb	E	A	Bb	B	C	D	F	F#	G#	C#	G

Figure 4-11: Series 'I'

4.2.2.1 Forming Matrix 'O'

The formation of the matrices draws obvious comparisons with the Vigenère Square. The order of series 'O' gave Boulez the position of subsequent transpositions within matrix 'O'. By moving sequentially through 'O' (Eb, D, A, Ab, and so on), each note was used as the starting note of a new transposition. The first transposition began on D, and was equivalent to lowering series 'O' by a minor second.

Pitch Number	2	8	4	5	6	11	1	9	12	3	7	10
'O' Trans 1	D	C#	Ab	G	F#	F	Eb	C	B	A	E	Bb

Figure 4-12: First transposition of series 'O'

Because each note also had a numerical value, transposition not only changed the order of the notes, but also the order of the numerical sequence. The order of the intervals, however, remained the same. The second transposition began on A, and was equivalent to lowering series 'O' by an augmented forth. Again, the order of the numerical sequence was altered as a result of transposition, but the order of intervals was unaltered.

Pitch Number	3	4	1	2	8	9	10	5	6	7	12	11
'O' Trans 2	A	Ab	Eb	D	C#	C	Bb	G	F#	E	B	F

Figure 4-13: Second transposition of series 'O'

As far as numerical patterns are concerned, this procedure is a simple form of PRN generation where upon consecutive transpositions of the seed (the 'O' series) produce a matrix of quasirandom numbers. Without knowledge of the seed value or the method of generating subsequent numerical combinations, it would be hard to predict such patterns by visual inspection alone. However, some patterns are detectable, particularly along the top, and the left-hand side of the matrix. The completed matrix 'O' looked as follows:

1	2	3	4	5	6	7	8	9	10	11	12
2	8	4	5	6	11	1	9	12	3	7	10
3	4	1	2	8	9	10	5	6	7	12	11
4	5	2	8	9	12	3	6	11	1	10	7
5	6	8	9	12	10	4	11	7	2	3	1
6	11	9	12	10	3	5	7	1	8	4	2
7	1	10	3	4	5	11	2	8	12	6	9
8	9	5	6	11	7	2	12	10	4	1	3
9	12	6	11	7	1	8	10	3	5	2	4
10	3	7	1	2	8	12	4	5	11	9	6
11	7	12	10	3	4	6	1	2	9	5	8
12	10	11	7	1	2	9	3	4	6	8	5

Figure 4-14: Matrix 'O'

Matrix 'I' was calculated in a similar fashion and, by reading matrices 'O' and 'I' from right to left, the retrogrades matrices 'R' and 'RI' were formed.

4.2.2.2 Organisation of Musical Elements

The organisation process used by Boulez can be divided into two categories: 1) elements of the composition derived directly from matrices (i.e., note order, note duration, order of note duration, dynamic and mode of attack), and 2) those chosen according to an unrelated scheme or arbitrary decisions (i.e., the overall form, octave, meter and rests). This section discusses the former of these categories, since it is Boulez's use of matrices to generate patterns of notes that is most identifiable with the Vigenère Cipher and consequently, PRN generation.

1. Note Order: Having organised the transpositions within the matrices, the order in which they were used was determined by a master plan. This involved dividing *Structures 1a* into two simultaneously heard piano parts, A and B, with twelve series per piano in each part.

Piano 1	Part A	Part B
	All twelve series based on 'O' in order 'I'	All twelve series based on 'RI' in order 'RI'
Piano 2	All twelve series based on 'I' in order 'O'	All twelve series based on 'R' in order 'R'

Figure 4-15: Transposition master plan

1	2	3	4	5	6	7	8	9	10	11	12
7	1	10	3	4	5	11	2	8	12	6	9
3	4	1	2	8	9	10	5	6	7	12	11
10	3	7	1	2	8	12	4	5	11	9	6
12	10	11	7	1	2	9	3	4	6	8	5
9	12	6	11	7	1	8	10	3	5	2	4
2	8	4	5	6	11	1	9	12	3	7	10
11	7	12	10	3	4	6	1	2	9	5	8
6	11	9	12	10	3	5	7	1	8	4	2
4	5	2	8	9	12	3	6	11	1	10	7
8	9	5	6	11	7	2	12	10	4	1	3
5	6	8	9	12	10	4	11	7	2	3	1

Figure 4-16: Transpositions of matrix 'O' in the order 'I'

In Piano I/Part A, each series based on 'O' was ordered according to the notes forming series 'I'. In *figure 4-16*, 'I' can clearly be seen in the leftmost column, placing order upon the transposed rows of 'O'.

As with matrix 'O', at first glance, this ordering may be perceived as random since it is hard to identify a pattern, however, the diagonal line of 1's running from top left to bottom right suggests that an ordering process is taking place. Such features can occur in basic methods of PRN generation, but patterns that emerge through visual inspection are often harder to perceive aurally, and vice versa.

2. Duration Order and Duration: The order of durations was generated in a similar way, using a slightly different master plan (see *figure 4-17*). Durations were calculated to be the product of the numerical value of the note multiplied by a basic time unit of a demisemiquaver. The duration master plan was mapped directly onto the pitch master plan.

Piano 1	Part A	Part B
	All twelve series based on 'RI' in order 'RI'	All twelve series based on 'I' in order 'R'
Piano 2	All twelve series based on 'R' in order 'R'	All twelve series based on 'O' in order 'RI'

Figure 4-17: Duration master plan

3. Dynamics: Each series had its own dynamic arrived at from the diagonals of matrix 'O' and matrix 'I'. Piano 1 used the diagonals found in matrix 'O' to generate its dynamics (see *figure 4-18*); each of the twenty-four diagonal numbers represented a dynamic value, which was applied in turn to each of the twenty-four series which make up Piano 1. The same process, using matrix 'I' instead, is used to generate the dynamics for Piano 2.

						7					12
							9			7	
								6	7		
								11	1		
							11			3	
						5					2
7					5						
	9			11							
		6	11								
		7	1								
	7			3							
12					2						

Figure 4-18: Diagonals of Matrix 'O' Used to Determine Dynamics for Piano 1

1	2	3	4	5	6	7	8	9	10	11	12
pppp	*ppp*	*pp*	*p*	*quasi p*	*mp*	*mf*	*quasi f*	*f*	*ff*	*fff*	*ffff*

Figure 4-19: Key used to determine dynamics

4. Modes of Attack: These were generated and assigned in very similar way, using the opposite diagonals in conjunction with a key comprising various different types of attack.

Although Boulez's methods involved more stages than described above, the consequences of his approaches to organising material (by way of matrices, transpositions and the mapping one sort of information onto another) are similar to those experienced when using the Vigenère Cipher, i.e., the generation of quasirandomness. *Structures 1a* also behaves rather like a PRN generator, creating a lot of information from a small seed. What follows is a look at how the encryption techniques discussed in this section can be integrated with serial procedures.

4.3 QUASIRANDOM COMPOSITION PROCEDURES

By way of a series of composition-based experiments, this next section looks at several ways of combining PRN generation and music. The different techniques explored include some that are serial in nature (including binary serialism) and others that are based on formalised techniques derived from cryptography. The success rate of these experiments (their ability to generate stand-alone compositions) is variable, but in terms of generating quasirandom sounding material, or music that may be perceived as random to a degree, they succeed.

Common to the first three experiments is the use of a "binary grid" (see page 280), which may be used as a type of PRN generator. This large block of binary code takes on a similar construction to the Vigenère Square (it even contains a diagonal pattern), but instead of shifting vertically through the alphabet, it is created by rotating through a random series known as a "binary sequence". This consists of pitches (selected at random) expressed in binary; in other words, each pitch has a corresponding, four digit, binary number assigned to it. The series is comparable to a seed because the output of the system depends upon the order of its pitches. In fact, regardless of whether the series is generated randomly, binary sequences do look remarkably random (see page 231 for more on the perception of binary sequences). They contain patterns of alternation and repetition similar to those that would occur if they were the product of some chance procedure, e.g., flipping a coin. The quantity of 0's and 1's within a sequence depends on the range of binary numbers chosen to represent the original series (see *figure 4-20*). In turn, this can be used to investigate the effect a biased sequence has on the results of the PRN generator.

	A	B	C
1	0001	0100	0010
2	0010	0101	0011
3	0011	0110	0100
4	0100	0111	0101
5	0101	1000	0110
6	0110	1001	0111
7	0111	1010	1000
8	1000	1011	1001
9	1001	1100	1010
10	1010	1101	1011
11	1011	1110	1100
12	1100	1111	1101

Figure 4-20: Three possible binary representations

The above chart shows three possible ways (A, B and C) of representing the numbers one to twelve in binary form. In column A there are twenty-six 0's and twenty-two 1's. In column B there are twenty 0's and twenty-eight 1's. In column C there are twenty-four 0's and twenty-four 1's.

When creating a binary grid, a binary sequence is repeated in a shifting pattern, placing the last digit of one row at the beginning of the next. *Figure 4-21* shows the first two lines of a binary grid; the highlighted '0' at the end of the first line of binary sequence is placed at the start of the next.

3	8	11	10	6	1	4	9	5	7	12	2
0011	1000	1011	1010	0110	0001	0100	1001	0101	0111	1100	001**0**
0001	1100	0101	1101	0011	0000	1010	0100	1010	1011	1110	0001

Figure 4-21: Section of a binary grid illustrating the method of displacement

A binary grid may at times be divided into smaller "sub-grids", which can impose a structural framework if used systematically. A binary grid based on a twelve-note series may be divided into twelve sub-grids (see page 280). Individual sub-grids are sixteen digits by twelve digits. The four versions of the series (original, inversion, retrograde and retrograde inversion) can be applied to the rows of the binary grid as required.

All the compositional experiments conducted in the following section were realised using a MIDI sequencer. Some make use of the randomisation facilities such software packages offer, e.g., Random Pitch Maps (RPMs), which can be successfully integrated into methods of composing using the binary grids. RPMs have the ability to randomly choose which pitches are heard. They allow the user to set a randomise function to occur on a) any pitch, b) range of pitches or c) pitches within a range. In conjunction with other standard MIDI effects such as transposition, echo and quantisation, RPMs are an effective tool.

4.3.1 Experiment I: Generation of Quasirandom Rhythm and Allocation of Timbre by way of Binary Serialism

The objective of the first experiment (*CD 1*, tracks 1, 2 and 3) was to explore the quasirandom properties of a binary grid (founded on a seed/series of pitches chosen at random) by interpreting the patterns of '0' and '1' within the grid to be rhythm, and by using its sub-grids to determine structure and instrumentation. Techniques associated with PRN generation and cryptography, such as the displacement of materials and use of coordinates to make selections, were used throughout.

Rhythm itself can be broken down into a binary language; drummers learn to co-ordinate the left and right halves of their bodies independently. One of the most basic snare drum rudiments is the "paradiddle", noted for the pattern RLRRLRLL (R=right-hand, L=left-hand). This corresponds exactly with the binary code 1011 0100 (11 and 4 in the decimal system) and, viewed within the context of serialism, could be the pitches of a series. Introducing biases towards '1' or '0' can produce other interesting effects, which may be effective when simulating instruments that have two states, where one occurs more frequently than the other, e.g., the hi-hat. A binary sequence could be created which averages 1's and 0's to the ratio of 3:1; for every three closed hi-hats there would be one open, implying more repetition than a 1:1 ratio (this is explored later in Experiment III, see page 157).

Of course, in reality drummers can play the hi-hat in a multitude of different ways: loud and soft; open, closed or in between; striking from above or below; hitting the edge, centre or bell of the cymbal; playing with the tip, handle or edge of the drum stick; clapping the cymbals together with the foot pedal; rattling the stick in between the two cymbals; all of the above with different beaters, and so on. The closer one looks at how an instrument is played the more complicated it becomes to simulate. It is therefore of interest to find ways of applying different timbres to the patterns found within a binary grid. What follows is a description of how this can be achieved, so that each binary digit is assigned a specific timbre, determined by its position within the binary grid.

Method

Processes of PRN generation require seeds. The degree of randomness of the seed may vary according to the intended application of the quasirandomness generated.[21] In this experiment, the seed was produced by drawing cards numbered from one to twelve (to represent the twelve pitches of the chromatic scale) out of a bag.

8	3	6	11	10	1	2	7	12	5	4	9
1001	0100	0111	1100	1011	0010	0011	1000	1101	0110	0101	1010

Figure 4-22: The seed or series 'O' converted into binary code[22]

This was converted into a binary sequence with an equal quantity of 0's and 1's (24 of each) by representing each of the twelve pitches with binary numbers ranging from 0010 to 1101 rather than from 0001 to 1100. The binary grid based upon this sequence (see page 280) was divided into twelve equal sub-grids of binary code, labelled SG1 to SG12 (see *figure 4-23*), each measuring sixteen digits by twelve digits (later this is used to define the harmonic structure of the entire piece). The series was written along the left-hand side of the binary grid in its four forms: original (O), inverse (I), retrograde (R) and retrograde inversion (RI).

[21] Basic methods of seed generation in computers include using the co-ordinates of the mouse or the time and date, but these may not be considered random enough for applications where security is important, e.g., cryptography.

[22] This series is interesting because there are never more than three consecutive 0's in it at a time, so that a group of four digits always contains at least one '1' or one '0'.

Sound Bank	Note Row	8,3,6,11	10,1,2,7	12,5,4,9
1	O	SG1	SG5	SG9
2	I	SG2	SG6	SG10
3	R	SG3	SG7	SG11
4	RI	SG4	SG8	SG12

Figure 4-23: Sub-grid layout

A separate chart was used to determine the percussion noises that would sound for each digit (see *figure 4-24*). A bank of percussion sounds was allocated to each of the four rows of sub-grids. The first eight percussion sounds in each bank were different; the last four were always the same, i.e., hi-hat open (H-HO), hi-hat closed (H-HC), snare (Sn) and bass drum (BD):

0's	1's	Sound
12	1	1
11	2	2
10	3	3
9	4	4
8	5	5
7	6	6
6	7	7
5	8	8
4	9	9 H-HO
3	10	10 H-HC
2	11	11 Sn
1	12	12 BD

Figure 4-24: Chart used to determine the ordering of percussion sounds

Percussion sounds were assigned in the following way: the first row of the binary grid (beginning 10010100…) is numbered '8'. The first digit of this line is '1' (as in **1**001...) and this is assigned sound 8/bank 1. This is selected by reading across from the '8' in the

1's column to the corresponding percussion sound, in this case, sound 8. The next digit is a '0' (1001...). Reading across from the '8' in the 0's column corresponds to sound 5/bank 1.

Having worked out the percussion sounds for the first line of SG1 (the first 16 digits of the row numbered '8') the process was then repeated with the last line of SG1 (the row numbered '9', beginning 11001011...). The corresponding drum sound for a '1' in this row is sound 9, for a '0' it is sound 4.

The first and last lines of SG1 were then merged to create a four-voice percussion pattern. This whole process was then repeated with the second line from the top and second line from the bottom, the third line from the top and the third line from the bottom, and so on, until each digit of SG1 had been converted into a percussion pattern. This process was repeated for the remaining eleven sub-grids. Each digit was assigned a fixed duration of one semiquaver, with tempo set at 120bpm (i.e., neither tempo or duration were defined by the process).

	SG 1				SG 5				SG 9			
	8	**3**	**6**	**11**	**10**	**1**	**2**	**7**	**12**	**5**	**4**	**9**
8	1001	0100	0111	1100	1011	0010	0011	**1000**	1101	0110	0101	1010
3	0100	1010	**0011**	1110	0101	1001	0001	1100	0110	1011	0010	1101
6	1010	0101	0001	1111	0010	**1100**	1000	1110	0011	0101	1001	0110
11	0101	0010	1000	1111	1001	0110	0100	0111	0001	1010	**1100**	1011
10	1010	1001	0100	0111	1100	1011	0010	0011	1000	**1101**	0110	0101
1	**1101**	0100	1010	0011	1110	0101	1001	0001	1100	0110	1011	0010
2	0110	**1010**	0101	0001	1111	0010	1100	1000	1110	0011	0101	1001
7	1011	0101	0010	1000	1111	1001	**0110**	0100	0111	0001	1010	1100
12	0101	1010	1001	0100	0111	1100	1011	0010	0011	1000	1101	**0110**
5	0010	1101	0100	1010	**0011**	1110	0101	1001	0001	1100	0110	1001
4	1001	0110	1010	**0101**	0001	1111	0010	1100	1000	1110	0011	0101
9	1100	1011	0101	0010	1000	1111	1001	0110	**0100**	0111	0001	1010

Figure 4-25: Section of binary grid showing 'O' along left-hand side and three sub-grids

With the percussion pattern (*CD 1*, track 1) complete, the next stage was to explore methods of generating melodic elements and structure from patterns within the binary grid. Two different approaches were pursued. In the first (*CD 1*, track 2), a bass line was created using the highlighted binary numbers (see *figure 4-25*) as rhythm, where 1=note and 0=rest, with the duration of each set at a semiquaver. The highlighted pattern was formed from a process of PRN generation, where values of series 'O' down the left-hand side of *figure 4-25* were used to select four-digit binary numbers from each column. In SG1, the row labelled '1' (sixth from the top) selected 1101 from the column labelled '8'. Pitch 8 was assigned to the rhythm pattern 1101 (pitch 3...1010, pitch 6...0011, pitch 11...0101, etc). Each group of 16 semiquavers was looped six times to last the length of the sub-grid, there being 96 in total. SG1's bass line was then followed by one generated from SG5 (i.e., the sub-grids were used from left to right, rather than in numerical order).

The binary grid was used to generate pitch information for a tuned percussion pattern. On this occasion, note duration was created from the four-digit binary number highlighted in bold. That is, pitch 8 of the original series has a duration of 1101 or 13 semiquavers; pitch 3 of the series, has a duration of 1010 or 10 semiquavers. Each note begins once its predecessor has completed its duration. Exactly the same process was then used on the 'I', 'R' and 'RI' portions of the binary grid *(see figure 4-23)*, producing a melody for tuned percussion approximately a quarter of the length of the percussion part. So that this melody lasted for the full length of the percussion part, its inversion, retrograde and retrograde-inversion forms were also used.

Once this pitch and duration information had been collected, it was placed alongside the drum part. Octave information was gathered by dividing each of the twelve sub-grids of binary code into four ranges: in MIDI terms, E2-D#3, E3-D#4, E4-D#5 and E5-D#6. Referring to *figure 4-25*, the top three lines of binary sequence (8, 3 and 6) were in the E2-D#3 range, relating to the pitches 6, 1 and 7; the next three lines (11, 10 and 1) in the E3-D#4 range, and so on. An echo effect was added to the whole tuned percussion line to enhance the timbre and where it occurred in sub-grids 6, 10, 3, 7 and 12 it was doubled by guitar and strings.

In the second approach (*CD 1*, track 3), the melody generated for tuned percussion above was used for a guitar, and its reverse, lowered by two octaves, became a bass line. To add structural variety missing from the first, rests were added to the percussion part based upon the original series: eight beats rest after SG1, three beats rest after SG2, and so on. The guitar and bass were sped-up and looped during the rests. The number of times they were looped was the same as the number of rests. Thus, during a rest of two beats, the guitar and bass would double their speed and loop twice.[23] Tempo changes were introduced to create rhythmical interest. The keyboard modulation wheel was used to improvise tempo changes,[24] making it possible to leap from 20bpm to 400bpm.

Results

In the percussion pattern, the rotation through the four sound banks, or at least the changeover from one bank to the next upon the completion of a cycle, generates a perceivable degree of order. This originates from the division of the binary grid into sub-grids and gives the impression that repetition is occurring at a structural level. As for the rhythmical material, there is a definite "random feel". The combination of alternation and repetition between the two layers of binary sequence provides an unpredictable listening experience, despite being determined from the outset. Using the binary grid as a method of generating material this way limits the amount of variation and it is fair to say that the system would produce very similar pieces regardless of the original series. In a sense, it is non-teleological because it contains no dynamic contrast, no climax. Then again, the process can only produce a finite amount of material, implying the end is very much an established feature. The percussion pattern can be represented in three-dimensions in the following manner (see *figure 4-26*). The *x*-axis shows the relatively small amount of randomness (the randomly picked series/seed) used to generate a larger amount of material. The *y*-axis shows that the control factor is high, with pitch, rhythm and structure derived

[23] It has since become apparent that the final looped guitar line (nine loops) is missing from track 3.
[24] This technique was used by Zappa in his Synclavier music.

from the binary grid system. Both randomness (the quasirandom details) and order (the structure imposed by the binary grid) may be perceived (z-axis), with randomness predominating slightly.

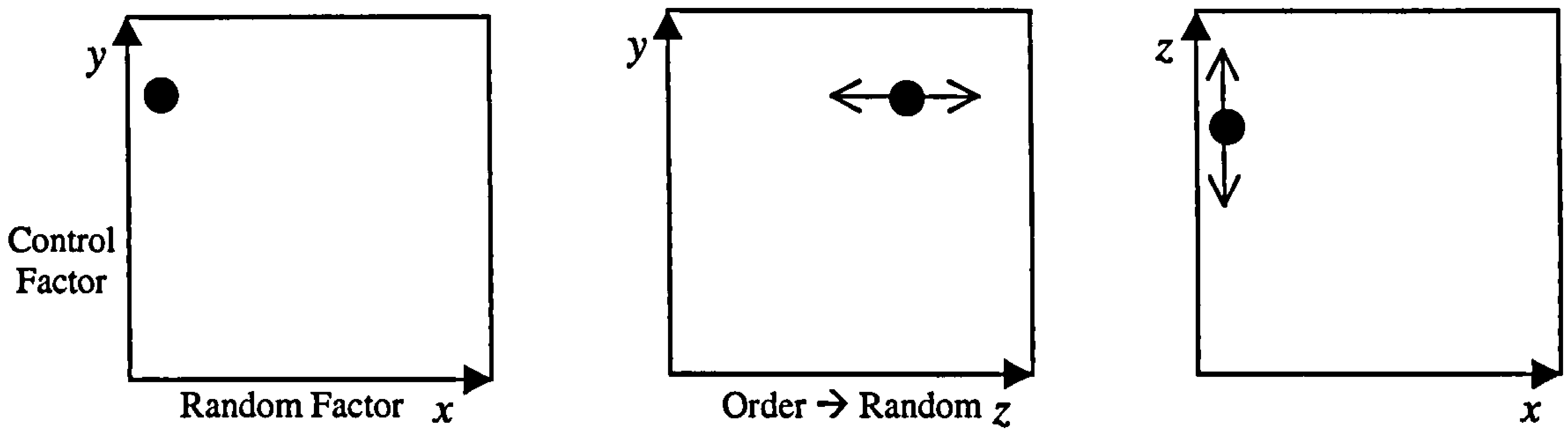

Figure 4-26: Degrees of randomness and order, in process and perception, of the percussion pattern in Experiment I *(*CD 1, *track 1)*

The two different methods of generating material to accompany the percussion part have very different characteristics. The first sounds like a piece of techno music, albeit far too intricate to actually be techno. This has lot to do with the choice of timbre (electronic percussion sounds, synthetic bass), but also the rigid tempo. One key difference between this and techno is the absence of a bass drum on every beat. The slow attack of the strings results in a strange warping effect where notes with short durations fail to sound, but longer ones succeed. The sense of order imposed by the binary grid is still present and this is enhanced by the repetition of the bass line; and yet there is still a sense of unpredictability. A three-dimensional representation of this would be similar to that shown in *figure 4-26,* but with perception possibly closer to order than randomness.

The second approach is far more abstract. The guitar melody sounds very unpredictable. Structurally, there is a very clear pattern, in the sense that the percussion part is interspersed with rests, at which point the guitar and bass perform a loop. But the exactness of this pattern, i.e., how long each rest is, is less easy for the listener to guess, especially since the overall tempo is constantly varied.[25] In *figure 4-27*, the control factor is once again shown to be high. As with each of the above stages, the process does not determine tempo. In this instance it is improvised unpredictably throughout, so the amount of control exerted by the system and perceived degree of randomness both increase, although some order may be still be detected.

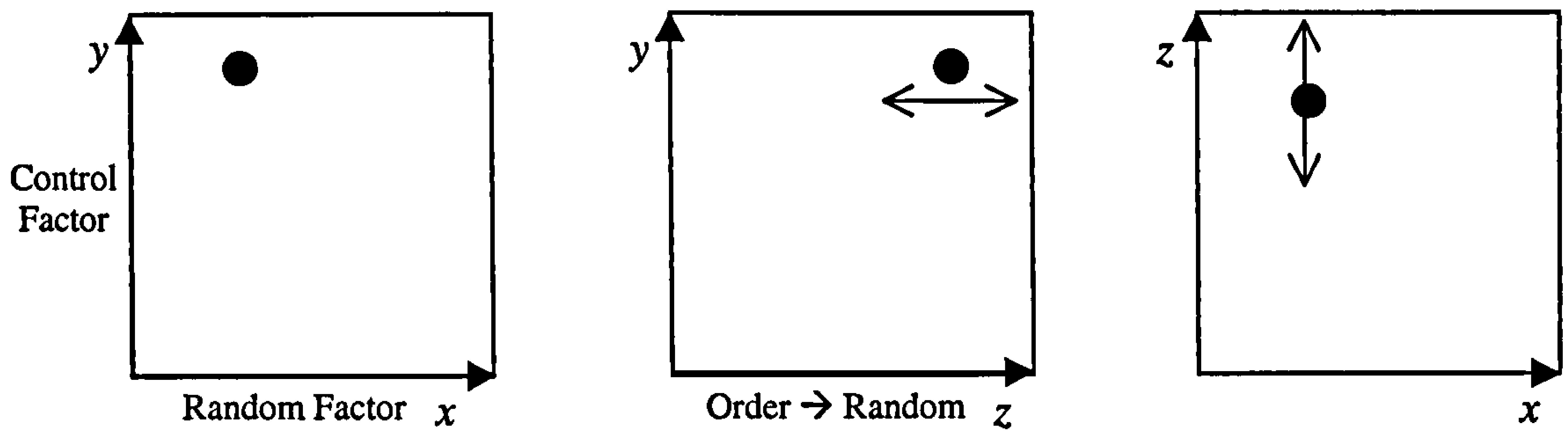

Figure 4-27: Degrees of randomness and order, in process and perception, of the second approach (CD 1, *track 3)*

4.3.2 Experiment II: The Application of RPMs to Binary Grids

Based on the same series 'O' used in the previous experiment, the following section describes a process of composing music (*CD 1*, track 4) through the application of RPMs and other MIDI effects (e.g., echo, transposition and quantisation) to patterns found within the binary grid (see page 280). Some of these effects place a degree of predictability on the material obtained from the grid; however, a sense of unpredictability remains due to the quasirandom rhythmical aspect.

[25] This idea of an improvised flexible tempo has also been applied to improvisations performed by the group formed alongside this research. These prove that although it is a rather unusual technique to apply to popular music, it can be quite successful.

Method

1. The binary grid was divided into sub-grids, each measuring sixteen by twelve digits and numbered as follows:

O	SG 1	SG 5	SG 9
I	SG 2	SG 6	SG 10
R	SG 3	SG 7	SG 11
RI	SG 4	SG 8	SG 12

Figure 4-28: The arrangement of sub-grids

2. Each series (O, I, R, RI) was divided between three RPMs, so that each RPM contained four pitches, known as the pitch set.

RPM	Pitch Sets	Series
1	8, 3, 6, 11	O
2	10, 1, 2, 7	
3	12, 5, 4, 9	
4	6, 11, 8, 3	I
5	4, 1, 12, 7	
6	2, 9, 10, 5	
7	9, 4, 5, 12	R
8	7, 2, 1, 10	
9	11, 6, 3, 8	
10	5, 10, 9, 2	RI
11	7, 12, 1, 4,	
12	3, 8, 11, 6	

Figure 4-29: Assignment of pitches to RPMs

3. A rhythm pattern was created from each sub-grid by counting from left to right the number of the pitch written along the side. The section of binary grid below (see

figure 4-30) shows that pitch 1 of series 'R' implies 1100; pitch 2 implies 0001; pitch 3 implies 1000 and so on:

Retrograde

	SG 3			
9	0011	1000	1101	0110
4	0001	1100	0110	**1011**
5	1000	1110	0011	0101
12	0100	0111	0001	1010
7	0010	0011	1000	1101
2	1001	**0001**	1100	0110
1	**1100**	1000	1110	0011
10	0110	0100	0111	0001
11	1011	0010	0011	1000
6	0101	1001	0001	1100
3	0010	1100	**1000**	1110
8	1001	0110	0100	0111

Figure 4-30: Section of binary grid illustrating the generation of rhythm

Sequences formed from this process were converted into rhythm by taking 1's to be semiquaver notes and 0's to be semiquaver rests; this meant each sub-grid had a 4/4 rhythm expressed as 16 semiquavers associated with it.

Source of Rhythm	Rhythm pattern	Allocated Bar Nos.
SG 1	1101101000110101=A	1, 13, 25, 37
SG 2	0110110110111010=B	2, 14, 26, 38
SG 3	**1100000110001011=C**	**3, 15, 27, 39**
SG 4	0001100111000110=D	4, 16, 28, 40
SG 5	0011110001101000=E	5, 17, 29, 41
SG 6	1011011110000010=F	6, 18, 30, 42
SG 7	1001101110101011=G	7, 19, 31, 43
SG 8	1000010011010110=H	8, 20, 32, 44
SG 9	0100110111000110=I	9, 21, 33, 45
SG 10	1110001011001110=J	10, 22, 34, 46
SG 11	0111100001110110=K	11, 23, 35, 47
SG 12	0110010001101010=L	12, 24, 36, 48

Figure 4-31: Bar allocation of rhythm, highlighting the rhythm pattern associated with SG3

4. The total rhythm (i.e., twelve bars formed from A+B+C+D+...+L) was repeated four times, producing forty-eight bars altogether. Owing to this repetition, rhythm patterns occurred at four different points, e.g., pattern A occurred at bars 1, 13, 25 and 37; pattern B occurred at 2, 14, 26 and 38, and so on (see *figure 4-31*).

5. With the rhythm complete, the next stage involved the application of the RPMs to instruments. *Figure 4-32* shows the layout for the first half of the piano part.

Bars / RPM	1-4	5-8	9-12	13-16	17-20	21-24
1	Rhythms A+B+C+D					
2		Rhythms E+F+G+H				
3			Rhythms I+J+K+L			
4				Rhythms A+B+C+D		
5					Rhythms E+F+G+H	
6						Rhythms I+J+K+L

Figure 4-32: Application of RPMs to twenty-four bars of the piano part

Here, the forty-eight bars (only twenty-four are shown above) were shared between the twelve RPMs, with each RPM assigned to a four-bar rhythm. To add variety, the rhythm pattern for each four-bar period was shared between four separate tracks, each containing a different combination of effects. The sharing process was based on the quasirandom pattern formed by the highlighted binary numbers; e.g., bars 1, 13, 25 and 37 use the highlighted pattern in SG 1 (see page 280).

Track	Rhythm Pattern A			
I			0011	
II	1101			
III		1010		
IV				0101

Figure 4-33:Rhythm pattern A shared between four tracks

Each track contained the following combination of effects:

Track	Effect
I	RPM: 4 pitches from note row (e.g., bars 1-4, RPM=8, 3, 6, 11). Echo: number of repeats=4, each repeat transposed one octave higher than its predecessor. Time delay duration: semibreve Quantise: crotchet
II	RPM: 4 pitches from note row (as above). Echo: number of repeats=4, each repeat transposed one octave higher than its predecessor. Time delay duration: semibreve Quantise: crotchet 4:3
III	RPM: 4 pitches from note row (as above). Echo: number of repeats=4, each repeat transposed one octave higher than its predecessor. Time delay duration: semibreve Quantise: semibreve
IV	RPM: 4 pitches from note row (as above). Transposition: One octave lower. Echo: number of repeats=4, each repeat transposed one octave higher than its predecessor. Time delay duration: semibreve Quantise: minim

Figure 4-34: Assignment of effects to each track

The echo effect was used to create ascending, semiquaver, octave arpeggios which, depending on the quantisation setting, could be used to create chords (i.e., when quantise was set to a note length greater than a semiquaver). Combined with the RPMs and echo, the four different quantise settings used in each bar introduce a more pianistic feel.

6. The bass line was made out of the same rhythm pattern and same RPMs (transposed to a lower octave) used in the piano part, e.g., bars 1-4 used RPM1 and rhythm pattern 1101101000110101011011011011101011000001100010110001100111000110.

7. The rhythm guitar line was created in much the same way as the bass line with the added use of echo and quantisation. The pitches were transposed to a typical rhythm guitar range. The quantise function was set at a crotchet so that a chord would sound on the beat, four times in a bar. A subtle echo was applied to this chord repeating it a semiquaver later and at a lesser velocity.

8. The percussion part used several RPMs, one solely controlling the snare drum and bass drum and others for the high-pitched percussion noises. A new quasirandom rhythm pattern was created from the binary grid so as to introduce some counterpoint between the percussion section and the other instruments. This was done by totalling the number of 1's in each column in a binary grid, where an even number of 1's produced a '0' (a semiquaver rest) and an odd number produced a '1' (a semiquaver note duration). The results for each column are indicated in bold typeface below.

SG 1

1001 0100 0111 1100
0100 1010 0011 1110
1010 0101 0001 1111
0101 0010 1000 1111
1010 1001 0100 0111
1101 0100 1010 0011
0110 1010 0101 0001
1011 0101 0010 1000
0101 1010 1001 0100
0010 1101 0100 1010
1001 0110 1010 0101
1100 1011 0101 0010
1010 0001 0110 0110

Figure 4-35: Method of generating rhythm for percussion instruments

For the snare/bass drum part an echo (set to repeat the note a semiquaver later) was used in conjunction with a simple RPM set to randomly choose either the snare or bass drum. For the other percussion sounds, four separate RPMs, each containing five different sounds rotated through the percussion rhythm in blocks of three bars.

Results

The results of this experiment are surprising. The rhythmical element is similar to that of Experiment I because 0's and 1's are again spread equally throughout the binary grid. The sets of pitches assigned to the sub-grids are very noticeable, forming a predictable harmonic rhythm. When interpreting the PRN generated material, timbre plays a key role. The instrumentation works well with the types of rhythm formed, lending the material a Latin American feel (a discovery made accidentally). Each time the piece is played the RPMs make different selections for the pitches that are heard, however, the overall harmonic progression remains the same for each performance because the order of twelve RPMs does not change.

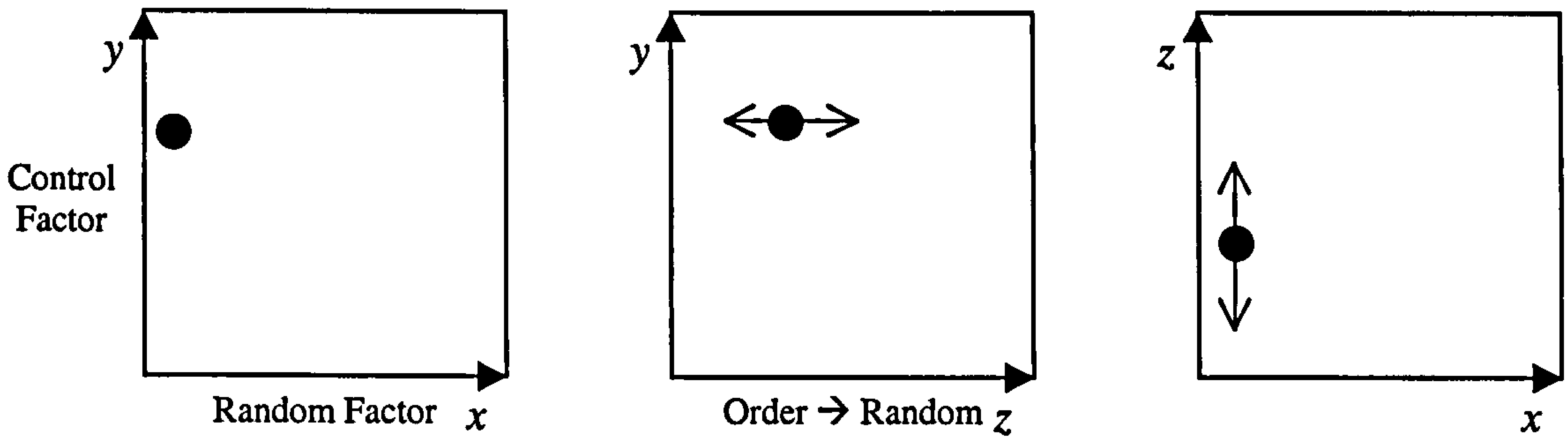

Figure 4-36: Degrees of randomness and order, in process and perception, in Experiment II *(CD 1, track 4)*

As with Experiment I, there is a sense here that the music generated is non-teleological, that despite its inherent rhythmical complexity, there is no sense of development, or tension and release. Consequently, it is plausible to make comparisons with some dance music where the emphasis on repetition and sampled loops means the music is highly restricted in how far it can develop. The systems of PRN generation explored here (RPMs aside) do not allow for much variance; changing the order of 'O' would not dramatically change the results in terms of structure (which is based on the presence of twelve sub-grids) and rhythm. Adhering to the principles set out above, the only way to alter the structure is by using a greater or lesser number of sub-grids and this implies using an 'O' series based on more or less than twelve pitches. The only way rhythm can be noticeably altered is by changing the ratio between 0 and 1, achievable by repeating notes within 'O', which in turn has repercussions on the harmonic aspect of the piece. Each of these ways of changing the seed value 'O' is looked at in the following experiment.

4.3.3 Experiment III: Testing the Impact of Different Series on the System Described in Experiment II

This experiment examines how series with repeated pitches affect the system described in the previous section. (*CD 1*, tracks 5, 6 and 7).

Method

A trial binary grid was created from the seed 1, 8, 8, 6, 1, 5, 2, 5 in which the notes of a major triad (1, 5 and 8) occur twice. This was a conscious decision designed to introduce more consonance into the melodic element than in previous experiments. The grid was then divided into eight sub-grids. A problem arose when generating the rhythm. In the previous experiment, the rhythm was generated by counting across, from left to right, the value of the series (and forms of) written down the left-hand side of the binary grid, each value of the series having an associated four-digit binary number assigned to it. With series that repeat pitches, the repeated pitches have more than one four-digit binary number associated with them; holes appear in which some pitches have no rhythm associated with them, i.e., 0000.

	1	8	8	6	1	5	2	5
1	**1000**	0111	0111	1000	0100	1001	1001	0100
8	0100	0011	1011	1010	1100	0010	0100	**1010**
8	0010	0001	1101	1101	0110	0001	0010	**0101**
6	1001	0000	1110	1110	1011	**0000**	1001	0010
1	**0100**	1000	0111	0111	0101	1000	0100	1001
5	1010	0100	0011	1011	**1010**	1100	0010	0100
2	0101	**0010**	0001	1101	1101	0110	0001	0010
5	0010	1001	0000	1110	**1110**	1011	0000	1001

Figure 4-37: Section of binary grid (SGs 1 and 5) based on an 8-tone series containing repeated pitches.

To overcome this, a technique was developed where an existing note row could undergo a pitch substitution; thus the original, un-substituted series could still be used to calculate the rhythm. In series iii, notes 7 and 8 are substituted for note 1; however, along the left-hand side of the binary grid iii (see pages, 281, 282, and 283 for all three binary grids referred to in this experiment), the un-substituted series is used to generate the rhythm.

While testing the system, a task based upon the aural comparisons of the music created by three series, the effects used to enhance the data were kept constant. The binary grids were constructed from three variations of the original series, each displaying different qualities. Series i contained eight notes, the white notes of the piano keyboard (from middle C to B) with the addition of one black note (Bb) in the same octave; the intention being that this scale might generate blues harmonies, as opposed to the chromaticism of using all twelve notes. The binary series contained an equal number of 0's and 1's, 16 of each.

3	4	8	6	1	7	2	5
1010	1011	0111	0101	1000	0110	1001	0100

Figure 4-38: Series i

Series ii used the same pitches as above, assigning to them a binary series biased towards 0 by a ratio of 5:3.

3	4	8	6	1	7	2	5
0010	0011	0111	0101	0000	0110	0001	0100

Figure 4-39: Series ii

The third series introduced the notion of substitution, where two notes within the previous series were substituted for another (in this case pitches 7 and 8 were both substituted for 1).

3	4	8(1)	6	1	7(1)	2	5
0010	0011	0000	0101	0000	0000	0001	0100

Figure 4-40: Series iii

It was expected that an increased bias toward zero (25:7) would noticeably break up the rhythm. Also, the increased occurrence of note 1 would hint at a tonal centre.

Results

Applying series i and ii to the system produced fairly similar results to Experiment II. The bias towards zero in series ii was barely detectable. In comparison to previous experiments, which were based upon dodecaphonic series, the emphasis placed on the major triad figuration in this experiment went some way to smooth out the implied harmonies generated by the RPMs, with fewer minor second intervals to cause dissonance. The third series test results produced the most satisfying outcome. The high ratio of zero to one led to a more fragmented rhythm which brought into focus the finer intricacies of the patterns produced by the system.

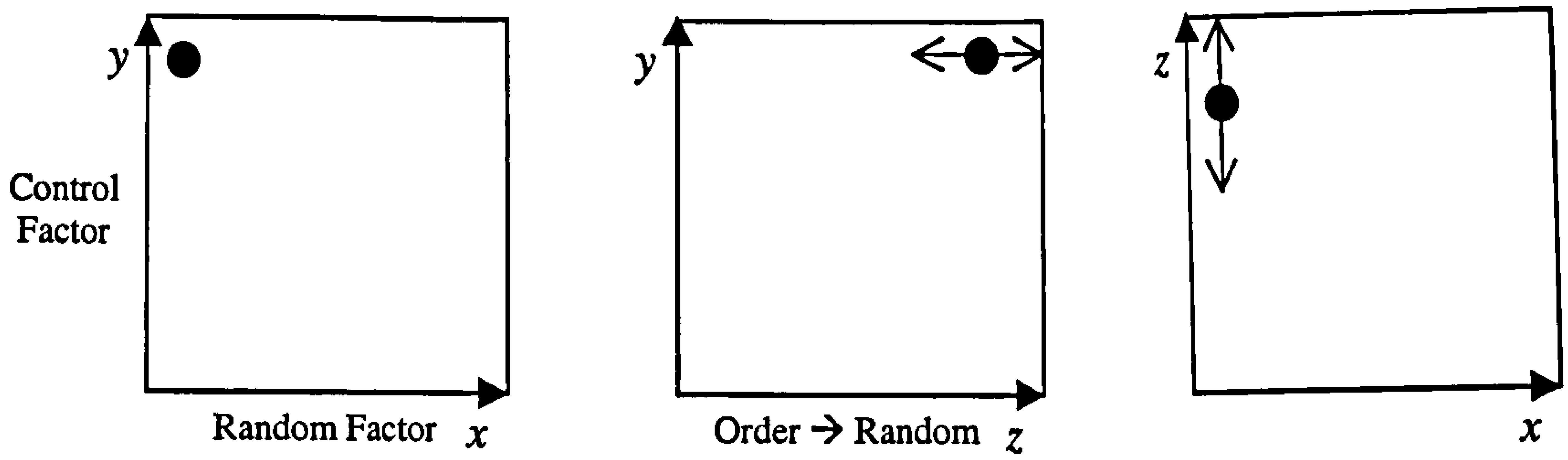

Figure 4-41: Degrees of randomness and order, in process and perception, of Experiment III, Series iii *(CD 1, track 7)*

In some ways the results of the experiment above work better as contexts or accompaniments. Jazz and rock solos often take place over non-teleological repeated figures fixed around a few notes. Although there is no sense of repetition in the three examples above, they can provide a similar accompanying role to whatever is placed over them. Improvisations also offer the listener something else to focus on amongst the surrounding quasirandomness. Several methods of applying a solo could be used, e.g., Zappa's technique of xenochronicity, where the solo would be taken from an unrelated source; or alternatively, an improvisation could be performed which "plays off" the quasirandom accompaniment.

Again, the role of timbre should not be underestimated as this also has a profound influence on how quasirandomness is perceived. Random pitches and quasirandom pitches may result in beautiful melodies (the infinite-monkey theorem) but are more likely to result in abstraction.

4.3.4 Experiment IV: Parametric Encryption of a Melody

Having ascertained that cryptographic and serial processes can function like PRN generators in 4.2, it follows that some cryptographic techniques can be applied to composition to encrypt musical material, parameter by parameter. This next experimental piece is in two stages. Both use techniques adapted from those found in cryptography. The first stage involves the encryption of eighteen notes from The Beatles number one hit, "I Feel Fine" (see *figure 4-42*). Explored are ways of incorporating Vigenère-style ciphers (based on displacement and substitution), Markov ciphers and keystream generation. The second stage, which is realised on computer, also references serial techniques and is more concerned with structural aspects. (*CD 1*, tracks 8 and 9).

The terminology is altered accordingly. The melody before encryption is called the "plain-melody", after encryption it becomes the "cipher-melody". Likewise, any musical parameter that undergoes a type of encryption is suffixed by "plain-", and once encrypted the parameter is suffixed by "cipher-", e.g., plain-duration/cipher-duration. As with *Structures 1a*, each parameter is approached independently.

Method: Stage 1

Different encryption techniques are applied to pitch and duration respectively, with the results of each process combined to produce the cipher-melody. Duration is encrypted by a Markov Cipher and pitch by a process derived from the Vigenère Cipher.
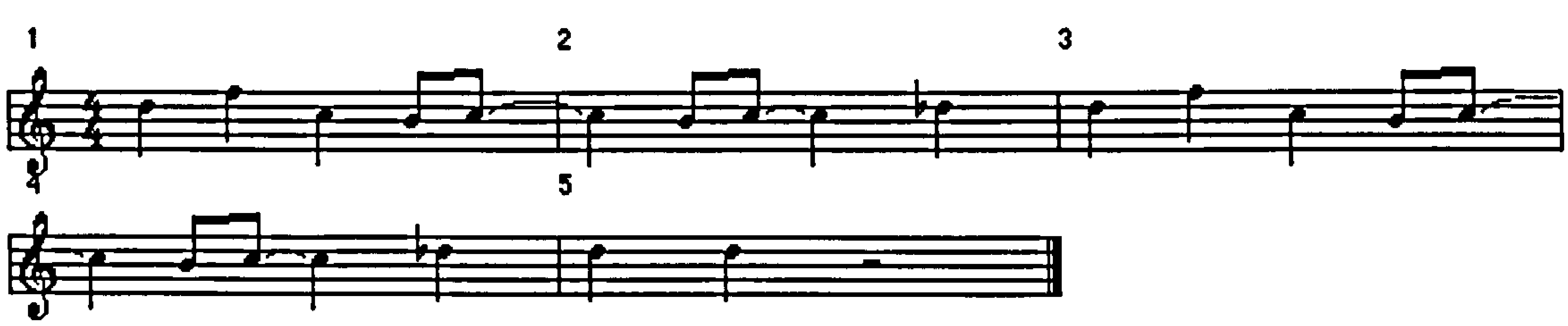
Figure 4-42: Open bars of "I Feel Fine" by The Beatles

Rhythm and Duration

The first stage of the encryption process involves converting the duration (D) of each note into its binary equivalent by way of the chart below:

0000	breve	1000	breve (.)
0001	semibreve	1001	semibreve (.)
0010	minum	1010	minum (.)
0011	crotchet	1011	crotchet (.)
0100	quaver	1100	quaver (.)
0101	semiquaver	1101	semiquaver (.)
0110	demisemiquaver	1110	demisemiquaver (.)
0111	hemidemisemiquaver	1111	hemidemisemiquaver (.)

Figure 4-43: Key used to determine duration

This process of conversion greatly expands the field of duration, contributing to the experience of unpredictability. Expressed as blocks where the sum duration is given by $D_{TOT}=D_1+D_2+\ldots+D_{18}$, the notes have the following durations shown as eighteen, four-bit sequences:

D_1	D_2	D_3	D_4	D_5	D_6	D_7	D_8	D_9
0011	0011	0011	0100	1011	0100	1011	0011	0011

D_{10}	D_{11}	D_{12}	D_{13}	D_{14}	D_{15}	D_{16}	D_{17}	D_{18}
0011	0011	0100	1011	0100	1011	0011	0011	0011

Cipher Duration

With duration now represented by binary code, a process of encryption based on a Markov Cipher can be performed where the cipher-duration is dependent on the value of that which precedes it. An encryption key (K) chosen at random is used so that the first block is encrypted (since it has nothing preceding it). In this example, K=1011. The value of C_1 is arrived at by XOR-ing D_1 and K and rotating the result 1 bit to the left. The formula for all subsequent values of C can be written thus, $C_n \Rightarrow D_n \oplus C_{n-1} \oplus K$, where C equals the result rotated one bit to the left each time.

$C_1 \Rightarrow D_1 \oplus K = 0011 \oplus 1011 = 1000$	$1000 \Rightarrow C_1 = 0001$	semibreve
$C_2 \Rightarrow D_2 \oplus C_1 \oplus K = 0011 \oplus 0001 \oplus 1011 = 1001$	$1001 \Rightarrow C_2 = 0011$	crotchet
$C_3 \Rightarrow D_3 \oplus C_2 \oplus K = 0011 \oplus 0011 \oplus 1011 = 1011$	$1011 \Rightarrow C_3 = 0111$	hemidemisemiquaver
$C_4 \Rightarrow D_4 \oplus C_3 \oplus K = 0011 \oplus 0111 \oplus 1011 = 1111$	$1111 \Rightarrow C_4 = 1111$	hemidemisemiquaver (.)
$C_5 \Rightarrow D_5 \oplus C_4 \oplus K = 1011 \oplus 1111 \oplus 1011 = 1111$	$1111 \Rightarrow C_5 = 1111$	hemidemisemiquaver (.)
$C_6 \Rightarrow D_6 \oplus C_5 \oplus K = 0100 \oplus 1111 \oplus 1011 = 0000$	$0000 \Rightarrow C_6 = 0000$	breve
$C_7 \Rightarrow D_7 \oplus C_6 \oplus K = 1011 \oplus 0000 \oplus 1011 = 0000$	$0000 \Rightarrow C_7 = 0000$	breve
$C_8 \Rightarrow D_8 \oplus C_7 \oplus K = 0011 \oplus 0000 \oplus 1011 = 1000$	$1000 \Rightarrow C_8 = 0001$	semibreve
$C_9 \Rightarrow D_9 \oplus C_8 \oplus K = 0011 \oplus 0001 \oplus 1011 = 1001$	$1001 \Rightarrow C_9 = 0011$	crotchet
$C_{10} \Rightarrow D_{10} \oplus X_9 \oplus K = 0011 \oplus 0011 \oplus 1011 = 1011$	$1011 \Rightarrow C_{10} = 0111$	hemidemisemiquaver
$C_{11} \Rightarrow D_{11} \oplus C_{10} \oplus K = 0011 \oplus 0111 \oplus 1011 = 1111$	$1111 \Rightarrow C_{11} = 1111$	hemidemisemiquaver (.)
$C_{12} \Rightarrow D_{12} \oplus C_{11} \oplus K = 0100 \oplus 1111 \oplus 1011 = 0000$	$0000 \Rightarrow C_{12} = 0000$	breve
$C_{13} \Rightarrow D_{13} \oplus C_{12} \oplus K = 1011 \oplus 0000 \oplus 1011 = 0000$	$0000 \Rightarrow C_{13} = 0000$	breve
$C_{14} \Rightarrow D_{14} \oplus C_{13} \oplus K = 0100 \oplus 0000 \oplus 1011 = 1111$	$1111 \Rightarrow C_{14} = 1111$	hemidemisemiquaver (.)
$C_{15} \Rightarrow D_{15} \oplus C_{14} \oplus K = 1011 \oplus 1111 \oplus 1011 = 1111$	$1111 \Rightarrow C_{15} = 1111$	hemidemisemiquaver (.)
$C_{16} \Rightarrow D_{16} \oplus C_{15} \oplus K = 0011 \oplus 1111 \oplus 1011 = 0111$	$0111 \Rightarrow C_{16} = 1110$	demisemiquaver (.)
$C_{17} \Rightarrow D_{17} \oplus C_{16} \oplus K = 0011 \oplus 1110 \oplus 1011 = 0110$	$0110 \Rightarrow C_{17} = 1100$	quaver (.)
$C_{18} \Rightarrow D_{18} \oplus C_{17} \oplus K = 0011 \oplus 1100 \oplus 1011 = 0100$	$0100 \Rightarrow C_{18} = 1000$	breve(.)

Pitch

The parameter of pitch is encrypted separately, using a table similar to a Vigenère Square. In order to use this type of encryption algorithm a key must be chosen. With Vigenère Ciphers, it is desirable that the keyword is short (three to five letters long) and does not contain letter repetition as this can expose patterns within the ciphertext, making it vulnerable. In addition, keywords are usually recognisable and memorable, rather than an obscure sequence of letters. Providing these conditions are met, the choice of keyword can be arbitrary. Deciding upon a key to use when encrypting a melody is a similar task. In this example, it was decided that it should be based on notes of a C-major triad, although, in theory, any short configuration of notes would meet the requirements. The figure below demonstrates how the first letter of the plain-melody is encrypted. The key-pitches are read across from the left-most, shaded column, whilst the plain-melody pitches are read down from the shaded row along the top. As with duration, the pitch field is enlarged by encryption. The table below (see *figure 4-44*) demonstrates how the value of the first cipher-pitch is arrived at.

	A	A#	B	C	C#	D	D#	E	F	F#	G	G#
A	A	A#	B	C	C#	D	D#	E	F	F#	G	G#
A#	G#	A	A#	B	C	C#	D	D#	E	F	F#	G
B	G	G#	A	A#	B	C	C#	D	D#	E	F	F#
C	F#	G	G#	A	A#	**B**	C	C#	D	D#	E	F
C#	F	F#	G	G#	A	A#	B	C	C#	D	D#	E
D	E	F	F#	G	G#	A	A#	B	C	C#	D	D#
D#	D#	E	F	F#	G	G#	A	A#	B	C	C#	D
E	D	D#	E	F	F#	G	G#	A	A#	B	C	C#
F	C#	D	D#	E	F	F#	G	G#	A	A#	B	C
F#	C	C#	D	D#	E	F	F#	G	G#	A	A#	B
G	B	C	C#	D	D#	E	F	F#	G	G#	A	A#
G#	A#	B	C	C#	D	D#	E	F	F#	G	G#	A

Figure 4-44: Table used to encrypt pitch

The first eighteen pitches of the melody are encrypted accordingly (all notes are natural unless indicated otherwise):

K	C	E	G	C	E	G	C	E	G	C	E	G	C	E	G	C	E	G
PP	D	F	C	B	C	B	C	C#	D	F	C	B	C	B	C	C#	D	D
CP	B	A#	D	G#	F	C#	A	F#	E	D#	F	C#	A	E	D	F#	G	E

Figure 4-45: Results of pitch encryption where K=Encryption key; PP=Plain-pitches; CP=Cipher-pitches

The eighteen cipher-durations and cipher-pitches were then combined to create a new melody – the cipher-melody – spanning one octave, with the highest pitch of the plain-melody, F, defining the upper limit of the cipher-melody. The result is a highly complex melodic shape,[26] the rhythm of which is highly detailed because of the expanded field of duration. It bears no resemblance to the plain-melody, with the exception that it still contains eighteen notes. The enlarged field of pitch adds further unpredictability to the melodic shape. Alternating patterns in the plain-melody are inconspicuous in the cipher-melody, e.g., the sequence C, B, C, B, C becomes D, G#, F, C#, A.
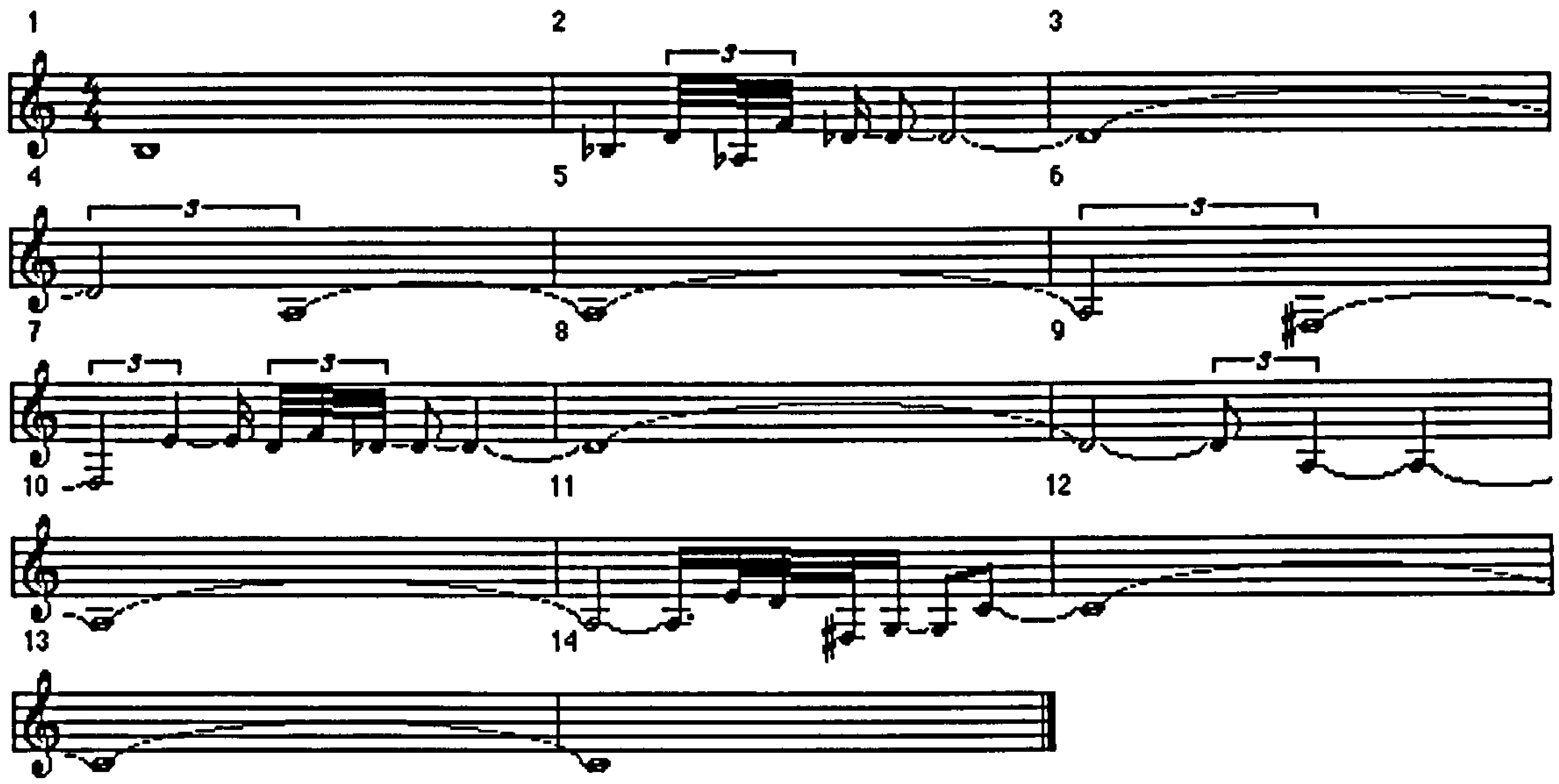
Figure 4-46: The Cipher-melody (CD 1, *track 8)*

Method: Stage II

Having established an encryption in the form of a cipher-melody, the next stage is to develop the structural aspects of the composition. The following method sets out a way of doing this through the application of further encryption and some serial techniques. Some of the decisions made at this stage are necessarily arbitrary. As Boulez discovered when

[26] Owing to software limitations, this notation is not one hundred percent accurate. Many of the durations used in the cipher-melody are small and irrational, and pose a problem for Digital Performer's notation program which searches for "best fit" solutions. These changes do not affect the actual playback.

facing non-equivalence in *Structures 1a,* patterns of notes cannot easily be translated into structure. The piece is arranged for sixteen instruments, but how this is done requires careful explanation. The score is initially set out like a Vigenère Square. The cipher-melody is allocated to instrument 1. Transposed versions of the cipher-melody (15 in total) are allocated to instruments 2 to 16 (drawing comparisons with Boulez's matrices). The transposition process involves raising the cipher-melody by a semitone each time. Each transposed cipher-melody also experiences a displacement to the right (recalling the alphabets in the Vigenère Square) of what is essentially an arbitrary amount, a semibreve rest (i.e., a bar of 4/4) multiplied by the degree of transposition. This serves to stagger the entrance of each cipher-melody.

Figure 4-47 shows the relationship between instrument, transposition and displacement. The right-hand column lists binary values from 0 to 15. These are used to provide further encryption by using the binary data obtained from the cipher-duration to determine which of the cipher-melodies is played.

Instrument No.	Amount of Trans. (semitones)	Displacement (semibreves)	C_n
1	0	0	0000
2	1	1	0001
3	2	2	0010
4	3	3	0011
5	4	4	0100
6	5	5	0101
7	6	6	0110
8	7	7	0111
9	8	8	1000
10	9	9	1001
11	10	10	1010
12	11	11	1011
13	12	12	1100
14	13	13	1101
15	14	14	1110
16	15	15	1111

Figure 4-47: The relationship between instrument, transposition and displacement.

Like a filtering system, melodies with a binary representation that matches that of a cipher-duration are selected. Referring to the cipher-duration (see page 163), it is shown that C_1=0001. *Figure 4-47* shows that 0001 corresponds with instrument 2, which will play the cipher-melody transposed by a semitone and shifted by a semibreve rest. Again, with reference to the results of the cipher-duration, C_2=0011. Therefore, instrument 4 will play the cipher-melody transposed by three semitones and shifted by three semibreve rests.

In this example, eight cipher-melodies are selected (performed by instruments 1,2,4,8,9,13,15 and 16). The remaining eight instruments, which are not assigned a melody by the value of C, take on the cipher-melody in its inversion.[27] *Figure 4-48* shows the layout of the melodies as two side-by-side, diagonal blocks. The shifting pattern is reminiscent of that found within the Vigenère Square. The right-hand block contains the melodies having undergone inversion; the left-hand block contains the melodies without inversion. This poses the possibility of yet further encryption. A keystream can be generated from K and used to indicate a bar number, which in turn can be used to reorder musical events. If K=1011, then the keystream=101100100011110. Reading along the length of the keystream four-bits at a time (i.e., **1011**00100011110, 1**0110**0100011110, 10**1100**100011110, etc.) it can be viewed as 15 unique blocks: 1011 0110 1100 1001 0010 0100 1000 0001 0011 0111 1111 1110 1101 1010 0101.

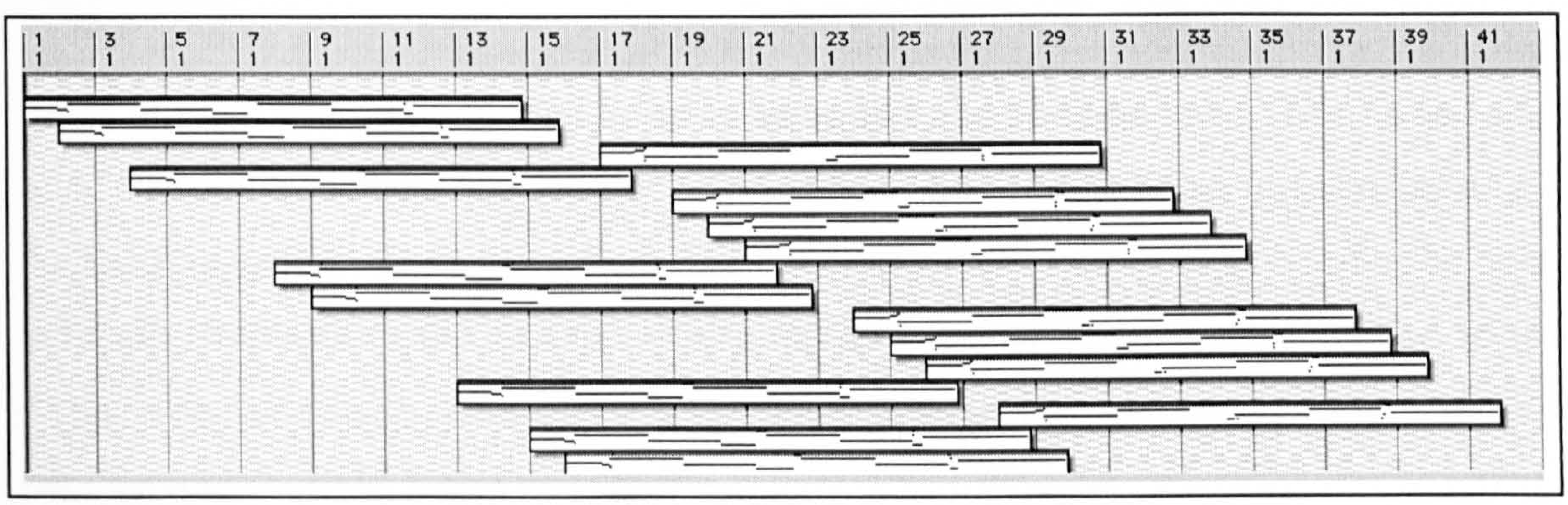

Figure 4-48: Screen shot of MIDI sequencer showing the layout of the material

[27] Inversion takes place around the first note of each melody.

When this is expressed in decimal it can represent bar numbers: 11, 6, 12, 9, 2, 4, 8, 1, 3, 7, 15, 14, 13, 10 and 5. This sequence of data is used to reorder the layout shown in *Figure 4-48*. Since this is forty-one bars long, the whole reordering sequence is repeated twice, shifting its values by fifteen each time. Note that the events of bar 11 occur first, followed by the events of bar 6, and so on. The figure below shows the results of conducting this process, which effectively quasirandomises the material further.

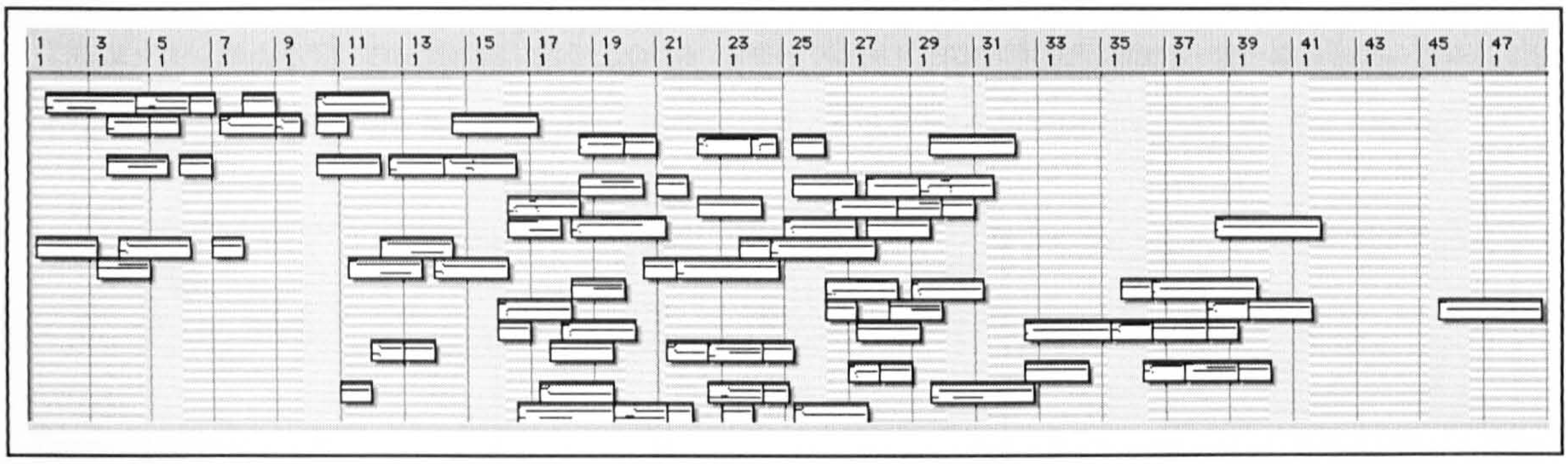

Figure 4-49: Screen shot of sequencer showing the layout of the material having been quasirandomised by a keystream

As a result of applying cryptographic processes to a melody, the music arrived at is highly unpredictable. The first stage, the encryption of the plain-melody, treated duration and pitch separately, using a Markov Cipher on duration and a Vigenère-style (polyalphabetic) cipher to encrypt the pitch. Recombining the two produced a cipher-melody with larger fields of pitch and duration than those found within the plain-melody. The second stage took the cipher-melody and reproduced it sixteen times, displacing and transposing it, similar to a canon. Then data obtained from a keystream was used to reorder the music vertically, fragmenting the material, whilst imposing further quasirandomisation. A section of the score (or at least, a sequencer's attempt at creating a score from some very peculiar note durations) can be found on page 284.

Results

The cipher-melody, prior to the manipulations of the second stage of the experiment, is a combination of very short and very long durations, which are difficult to predict. It bears no resemblance to the plain-melody. *CD 1*, track 8, contains two versions of the cipher-melody, adding a metronome pulse in the second. This highlights rhythmical irregularity, revealing how the pattern of notes falls outside a rigid tempo grid. It is possible to perceive a kind of melody because the notes with short durations pass so quickly and, like ornamentations, do not have a great influence on the perceived tonality of the whole.

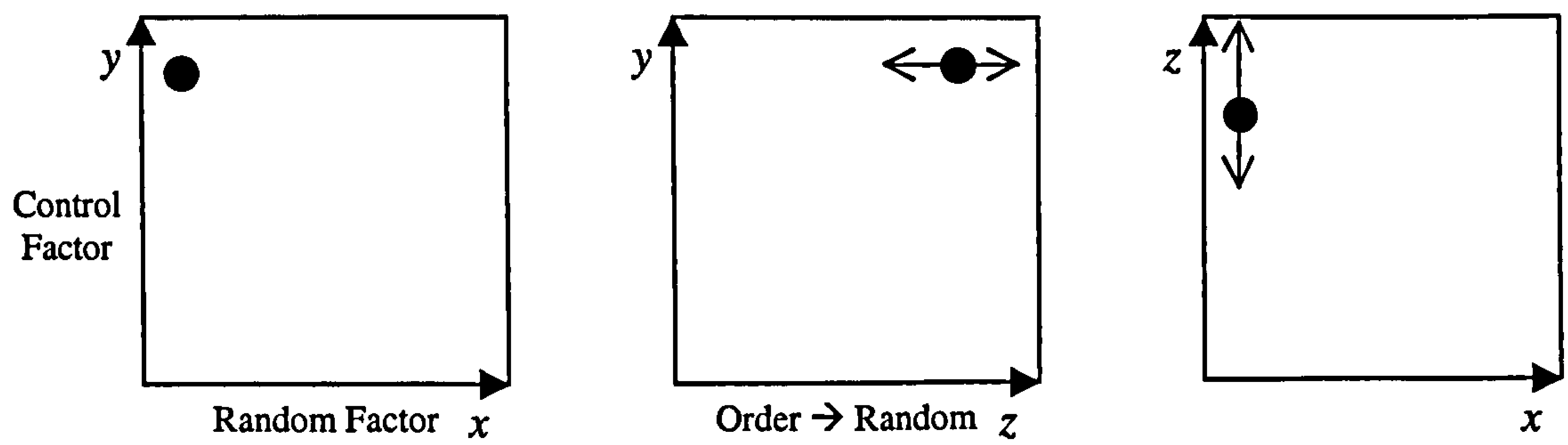

Figure 4-50: Degrees of randomness and order, in process and perception, in Experiment IV, stage I: *cipher-melody (*CD 1, *track 8)*

The quasirandom generative and ordering techniques used in the second stage of the experiment elaborate on this material but, interestingly, do not remove its basic characteristics. Listening to *CD 1*, track 9, it is possible to detect the patterns of fast notes and unusual intervals found in the cipher-melody. With the cipher-melody performed by sixteen voices, albeit in a fragmented, quasirandom way, it takes on a motif-like form. The repetition of identifiable musical figures may well influence the listener's perception. A three-dimensional representation might indicate a slight move towards order on the *z-axis* since reoccurring melodic shapes are detectable; however, there are still a number of random-sounding events, e.g., the long rest towards the end of the piece. The amount of transposition is also hard to judge.

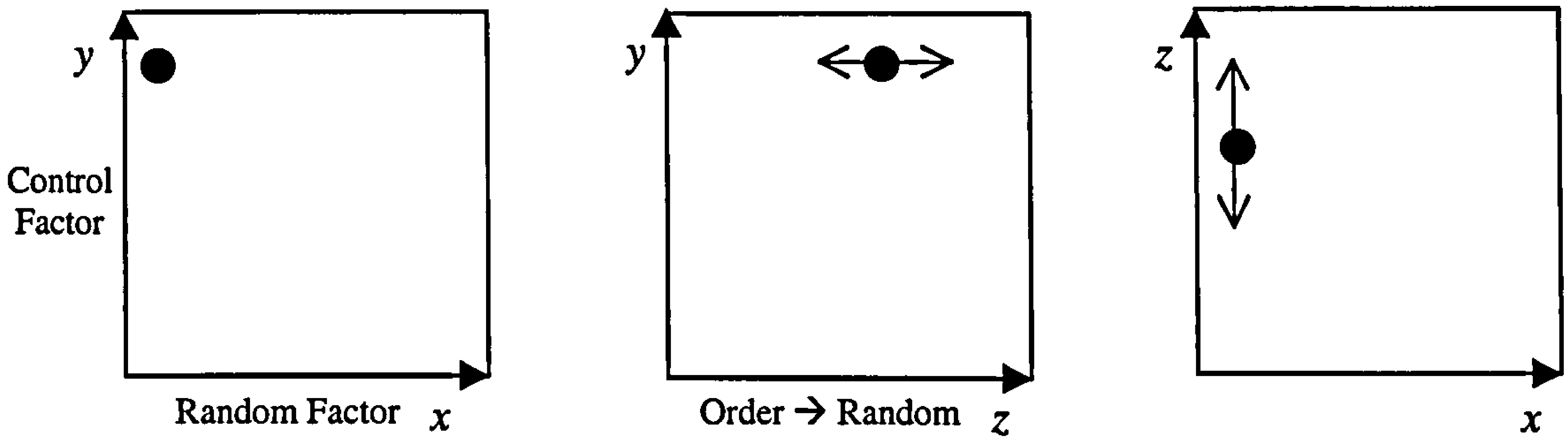

Figure 4-51: Degrees of randomness and order, in process and perception, in Experiment IV, stage II *(CD 1, track 9)*

4.4 SUMMARY

This chapter has aimed to show how quasirandom patterns can be generated through the use of cryptographic and serial techniques. Section 4.1 began by introducing the basic concepts of cryptography, along with several examples of encryption algorithms. It also explored the connection between serialism and cryptography, e.g., in the music of Berg. In section 4.2, this connection was expanded with an investigation of the similarities between the Vigenère Cipher and the techniques used by Boulez in *Structures 1a.* In section 4.3, four experiments into quasirandom composition were described, each employing ordering techniques derived from the Vigenère Cipher and *Structures 1a* to generate quasirandom material. These experiments produced a series of etudes rather than actual pieces; the success of each as a stand-alone composition needs to be viewed with this in mind. In terms of producing quasirandomness, however, they all succeeded.

The next chapter investigates the potential of quasiorder within composition. Defined in Chapter 1 as randomness perceived as order, quasiorder is in some ways more suited to chart-orientated popular music than quasirandomness because it appears to contain identifiable patterns.

CHAPTER 5

QUASIORDER: REPETITION AND RANDOMNESS

This chapter comprises three main sections and a summary, and investigates processes of generating quasiorder (randomness perceived as order) through an understanding of repetition (a characteristic of popular music associated with predictability) and its potential randomisation. It draws upon theories of repetition, structure and formulaic music. Section 5.1 discusses the kinds of repetition found in popular music, focusing on those identified by Middleton, and a theory of recycled music offered by Adorno in *On Popular Music.* A theory of sampling is also offered within this context. Section 5.2 investigates the link between structural predictability and repetition. In section 5.3, Middleton's findings are used to develop ways of combining randomness and repetition in compositional processes intended to present the listener with randomness that may be perceived as order. This section also offers a method of creating a quasiorder pop song.

Crucial to this chapter is Adorno's argument that standardised popular music listens for the listener (it is "pre-listened"), implying that it is inherently predictable. Through an understanding of the role repetition plays in this process, possible methods of randomly generating song structures may be realised for use within popular music. These are essentially quasiorder processes, since it is intended that the randomness they comprise is perceived as order. Section 5.1.1 begins with a discussion about repetition. Middleton argues that there are predominantly two kinds used structurally within popular music, but it can be argued that in today's popular music a third kind associated with sampling technology is also present. Adorno argues popular music's mass appeal is dependent on it being repetitive, but this assumes that repetition is something the masses crave.

Section 5.1.2 contains a discussion of the use of riffs in rock music and how this compares to the treatment of repetition by minimalist composers Terry Riley, Steve Reich and Brian Eno.

Section 5.2 investigates examples of popular music in which the three kinds of repetition discussed in the previous section play a vital role in the composition process and its perception. Section 5.2.1 discusses the rule-based, quasiordered composition system deployed by Jimmy Cauty and Bill Drummond of The Timelords and The KLF, in which samples of well-known music by other artists are used to satirise popular music through the accentuation of pre-listened musical characteristics. Their system places emphasis on the structural familiarities of pop songs, but allows freedom when choosing details. This openness to potential randomisation (whilst sounding predictable enough to appeal to the masses, i.e., quasiordered) is used to confirm Adorno's theory that in popular music the details are inconsequential to the structure.[1] Section 5.2.2 provides an investigation into John Oswald's uses of pre-existing sounds in "plunderphonics", which counter Cauty and Drummond's approach by exposing the structural limitations of popular music and proving that through the negation of standardised forms, patterns of repetition become harder to predict. The newly emerging "bootleg genre" can be viewed as the synthesis of Cauty and Drummond's use of pre-existing sounds and "pre-listened" song structures, and Oswald's approach to sonic manipulation. Section 5.2.3 compares the techniques, arguing that bootlegs are for the most part standardised and predictable.

Middleton's analysis of repetition is central to the three investigations conducted in section 5.3, which explore quasiorder processes of composition based upon randomising one of the most common forms of repetition in popular music: the riff. Section 5.3.1 examines a score-based system that utilises colour coding to indicate random pitches. Performers are required to choose and assign pitches according to the patterns of colours. In section 5.3.2, the basic design of a computer-based random riff generator is explained along with a

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[1] Adorno, Theodor, "On Popular Music", *Studies in Philosophy and Social Science*, New York, Institute of Social Research, 1941, IX, 17-48, para. 12.

number of test pieces. In section 5.3.3, a method of composing a quasirandom pop song, based upon combining the random riff generator, Cauty and Drummond's treatment of repetition, and the infinite-monkey theorem (see page 28), is investigated. Sound examples of all these methods are included on *CD 1*.

5.1 REPETITION THEORY

This section investigates repetition, which according to Adorno partially accounts for popular music's mass appeal. Adorno's argument, as set out in *On Popular Music*, implies repetition is an essential feature of all popular songs. Although he was most likely referring to Tin Pan Alley songs, some aspects still ring true today: much popular music does not demand attention because it is "standardised" and contains "pseudo-individualisation"; musical repetition is a symptom of this, since it does not require one's concentration.[2]

Repetition is an undeniably important aspect of popular music; if highly non-repetitive sounding music were as commercially viable, the pop charts would no doubt reflect this with free improvisations and Cage covers flooding the charts, but this is not the case. Repetition is simply better suited to the mass market. It is certainly hard to imagine popular music without repetition. Although repetition is closely associated with order, it is not (as one might assume) the opposite of randomness, which can after all contain repetition, e.g., one might achieve a run of "heads" when tossing a coin a number of times. Repetition can, likewise, behave randomly. The one thing uncertain about a repetition (unless indicated otherwise) is its end point, or more specifically, the number of repeats. In popular music, this uncertainty is largely removed through the use of familiar structures, e.g., verses and choruses, each sixteen bars long. The listener counting the bars does not

[2] Denny Walley, former guitarist with both Beefheart and Zappa, points out that the opposite is sometimes true from a performer's point of view: "The most difficult pieces to play turn out to be the easier songs because they are so repetitive in format. It makes it harder to count the measures. The more difficult material is in little packages and is therefore easier to remember". From a live chat broadcast by www.zappa.com, 11 February, 2003. http://www.zappa.com/cheezoid/whatsnew/this-just-in/ica/denny/edited-transcript.html

need to be told when the change will come because the structural standardisation of the song provides all the indications.

5.1.1 Repetition in Popular Music

From a purely functional perspective, repetition serves to expand what is essentially a small source of material; if all the repetitions were removed from a pop song, there would be very little left. Middleton uses the terms "musematic" and "discursive" to describe the two most common types of repetition found in popular music.[3] Typically, the musematic type is associated with the repetition of short musical elements or "units", an example being the use of riffs in rock music and grooves in Afro-American music. The discursive type is identifiable as the repetition of longer units, at the level of phrases and sections. Musematic repetition is "far more likely to be prolonged and unvaried"[4] whereas discursive repetition can be "mixed in with contrasting units of various types (as in the AABA structure [...])".[5] In this sense, repetition is a musical parameter, which may potentially be randomised. Whether the repetition is confined by the structure or the structure is defined by the repetition is a matter of perception.

Middleton uses the term "equivalence/difference spectrum"[6] to describe the numerous ways music combines these types of repetition with non-repetition to achieve its effects. And because musical systems tend to be multi-layered – a mixture of different ways of incorporating equivalence and difference – they do not sit neatly on the spectrum. Middleton talks of "compromises" to describe how, for example, a riff may be altered to fit an harmonic progression, and asserts that in light of these compromises the effects of repetition (how it makes the listener feel) must be "negotiable",[7] or unfixed, too. The ease

[3] Middleton, Richard, *Studying Popular Music*, Open University Press, Milton Keynes, 2000, p. 269.
[4] Ibid.
[5] Ibid.
[6] Ibid., p. 268.
[7] Ibid., p. 284.

by which these combinations of repetition and non-repetition are perceived has a considerable impact on their popular appeal.

Over the last twenty years, a third type of repetition has become commonplace in popular music: the sample. This differs from the musematic and discursive types of repetition because it is already a repeat, most commonly a short section of music, e.g., a drumbeat, taken from a pre-recorded source, which is looped and used in another song. In this context, the sample is a unit of repetition, and through looping the sample it is possible to achieve musematic repetition. The sample loop, given an Adornite interpretation, highlights the increasingly circular nature of popular music, because the unit of repetition has already been used elsewhere (i.e., in another piece of music). A possible reason why sampling has become so popular may stem from the music industry's own desire to recycle its products. Although it has never been very keen on samples being used without the permission of the owner, the music industry, especially the hip-hop and urban music sectors, depends heavily on samples. With musical trends repeatedly looking backward, the status of the "golden oldie" is confirmed time and time again.

The fashion industry offers the expression "retro" to describe its obsession with clothing styles of the past, but the expression is equally applicable to music and is in no way a new phenomenon. Adorno puts it down to the classic hits becoming "invested with the immunity of bigness" ('the King can do no wrong').[8] These timeless classics, responsible for generating huge profits, set the patterns that become standardised. In having to meet these standards, the cycle of repetition begins; time stands still, history ends. It is under these conditions that Adorno would argue that the possibility of movement by way of contradiction and critique disappears; there is no difference, only sameness (repetition).

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[8] Adorno, Theodor, "On Popular Music", *Studies in Philosophy and Social Science*, New York, Institute of Social Research, 1941, IX, 17-48, para. 18.

5.1.2 Repetition and Structure

Since musematic and discursive repetitions have structural implications, it follows that they are also concerned with the organisation of material. In popular music, musematic repetition is most noticeable in riffs, defined by Middleton as the repetition of short units. Riffs can be used in different ways to create a variety of effects depending on the structural demands of the piece, as Middleton explains:

> Riffs can be more or less the whole piece; alternatively, they can be a framework underneath a vocal and/or instrumental variative elaboration. They can be continuous, or worked into an antiphonal call-and-response pattern. They can be unchanging in pitch, or be 'pitch-layered' [...] against a chord progression. They can be melodically memorable or chiefly rhythmic in impact.[9]

Riffs are associated with predictability because they repeat a musical idea, but a riff is really only as predictable as the structure that contains it. In rock music, there are many familiar structures, for example, the twelve-bar blues. This standardised form dictates the harmonic movement of a riff, determining when the chord should change and for how long. Repetition is imbedded within the pattern, which spends two-thirds of its time on the tonic:

Bars	1	2	3	4	5	6	7	8	9	10	11	12
Chords	I				IV		I		V_7	IV	I	

Middleton states that this pattern is ingrained in popular music, becoming what Adorno would describe as completely naturalised. It is so familiar to listeners of rock that by the return to the tonic in the seventh bar, one is able to predict what the remaining five bars will bring. Other common structural devices in popular music include discursive forms of repetition, such as the ABAB form, sometimes called the verse-chorus form.

Although Adorno's *On Popular Music* still resonates today, it was originally an attack provoked by the predictability of Tin Pan Alley songs, which provided the staple supply of

[9] Middleton, Richard, *Studying Popular Music*, Open University Press, Milton Keynes, 2000, pp. 280-281.

popular music between 1890-1950. Middleton demonstrates this through an analysis of the song, "Down Mexico Way".[10] Like many songs of its type, the chorus takes on the predictable AABA form that Adorno refers to as one of the "best known"[11] rules. Discursive repetition plays an important role in the song's predictability since within the chorus the same music is heard three times.

> As for predictable harmonies [...] each of the four sections begins and ends on the tonic chord, and in between, complications are minimal: the primary triads (Eb, Bb, Ab – tonic, dominant, subdominant) are overwhelmingly in charge. The harmony [...] represents what, as Adorno points out, had come to seem the "natural" musical language. [12]

The use of a diminished chord is considered pseudo-individualisation since although it spices up the harmonic progression a little, it was a common practice of the day, a predictable feature. The melodic shape moves either by step or arpeggio, often sequentially, avoiding unexpected or large intervals. Rhythmically, the same patterns are affirmed throughout. Middleton concludes:

> [...] We can say the tune is predictable, not in the sense that without knowing it we are sure exactly what is coming next but in the sense that when we hear the next phrase, our reaction is, "yes, I thought something like that was coming".[13]

In popular music the repetition of riff-units seem predictable, but only because forms are familiar. Without the clues provided by common forms, there is no way of accurately predicting when the riff will change key or when it will eventually stop.

This point may be highlighted further by drawing a comparison with the techniques developed by minimalists such as Riley and Reich. The unpredictability of repetition is a key component of Riley's composition *In C* (1964). The piece contains fifty-two bars in the key of C. Performers are instructed to play the piece repeating each of these bars as often as they like. This combination of musematic repetition with indeterminacy creates

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[10] Michael Carr and Jimmy Kennedy, "Down Mexico Way" (1939)
[11] Adorno, Theodor, "On Popular Music", *Studies in Philosophy and Social Science*, New York, Institute of Social Research, 1941, IX, para 3.
[12] Middleton, Richard, *Studying Popular Music*, Open University Press, Milton Keynes, 2000, p. 46.
[13] Ibid., p. 48.

considerable complexity from what is a very simple idea. *It's Gonna Rain* (1965) by Reich uses an even simpler technique. The piece starts with two identical recordings of a preacher saying "It's gonna rain" playing alongside each other on two different tape machines. Gradually they go out of sync due to fractional differences between the motors of the tape machines. In the second half of the piece the number of voices is increased to four and finally eight. On the experience of listening to this piece, Eno remarks:

> If you stare at something for a very long time your eye quickly cancels the common information, stops seeing it, and only notices the differences.[14]

Inspired by these process pieces, Eno composed *Discreet Music* (1975) and *Music for Airports* (1978). Both albums made extensive use of loops of irregular length to generate material and heralded the beginning of the ambient music genre. Eno's use of multiple tape loops of different lengths running alongside each other is closely associated with how we perceive music. Placing less emphasis on the use of pre-existing recordings, his work provides an investigation of the unit of repetition, how rather than separating the loops in our minds we naturally hear them combined as an evolving piece of music. On *Music for Airports*:

> There are sung notes [...] one of the notes repeats every 23 1/2 seconds. The next lowest loop repeats every 25 7/8 seconds or something like that. The third one every 29 15/16 seconds [...] they all repeat in cycles that are called incommensurable – they are not likely to come back into sync again. [...] This is music for free in a sense.[15]

Paradoxically, although the music is founded on repetition, it is hard to detect the beginnings and endings of the repeats. Whereas the repetition of the details is detectable, there is no discernable sense of form, no discursive repetition for the listener to predict, which may lead to the mistaken conclusion that the music is random.

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[14] Eno, Brian, "Generative Music", a transcription of a talk delivered in San Francisco, 1996, *In Motion Magazine*. http://www.inmotionmagazine.com/eno1.html. This could also be the aural equivalent to "blindsight", a condition in which brain damage prevents suffers from being able to see, but permits them visual "cues", i.e., a sense of visual awareness and the ability to detect movement without actually seeing.
[15] Ibid.

5.1.3 Summary

This section has argued that three types of repetition seem to exist in popular music, Middleton's two kinds of repetition, musematic and discursive, and a third non-structural kind (although it may be treated as a unit of repetition), associated with sampled materials. Middleton argues that musical material exists along an equivalence/difference spectrum, linking the enjoyment of popular music not just to repetition, but also interruptions in the repetition which can occur unpredictably. The next section further explores the links between structure and the three types of repetition introduced above. It also addresses how quasiorder may be achieved through the randomisation of repetition and the influence this has on structure.

5.2 STRUCTURAL PREDICTABILITY AND THE TREATMENT OF REPETITION IN POPULAR MUSIC

This section discusses three different approaches to repetition and structure and aims to develop a better understanding of how quasiorder may be incorporated into popular music. What makes these first two approaches interesting is how they each highlight the connection between repetition and structural predictability. The first investigates Cauty and Drummond's attempt to formalise chart-orientated pop music with a set of rules, and discusses a possible connection between their approach and the theories of Adorno (the notion of pre-listening) and Middleton (musematic and discursive repetition). A potential randomisation of the system is also discussed. In the second, some of the uses of repetition employed in Oswald's "plunderphonics" are offered as comparative material. Oswald's music allows repetition to form structures which are often non-standardised, whereas Cauty and Drummond's method enforces structural standardisation upon repetition but allows the details within to be practically anything. The third approach, which may be considered a synthesis of the previous two, concerns the relatively new popular genre, bootleg. This uses pre-existing materials, often samples of entire songs, and applies "plunderphonic-style" techniques to introduce quasiorder.

5.2.1 The "Golden Rules" of Pop

Samplers have provided musicians with a way of taking the notion of recycling to a new extreme: the actual inclusion of pre-existing recordings in new works based on classic song formulas. During the late 1980s, the British song-writing partnership of Jimmy Cauty and Bill Drummond produced a string of UK number one singles under various names, such as The Timelords, The JAMS and most famously The KLF. Underpinning this success was a commitment to a set of "Golden Rules", a list of structural considerations, which left the internal details open to potential randomisation. These rules were eventually set out in their book *The Manual: How to have a Number One the Easy Way*, which turned the story behind their first number one into a system. In the tradition of similar titles, such as *How to Write and Sell a Hit Song* (1939) by Abner Silver and Robert Bruce, and more recently *Song Writing for Dummies* (2002) by Jim Peterik, Dave Austin and Mary Ellen Bickford, *The Manual* is a Situationist satire, presenting itself as a bluffer's guide to song-writing and the music industry. It bypasses the tempered approach adopted by similar titles of the day, for example, *Making it in the New Music Business* (1988) by James Riordan, which covers similar ground but makes no grandiose claims to be the key to a number one hit. The "Golden Rules" are described thus:

> Firstly, it [a number one song] has to have a dance groove that will run all the way through the record [...]. Secondly, it must be no longer than three minutes and thirty seconds (just under three minutes and twenty seconds is preferable) [...]. Thirdly, it must consist of an intro, a verse, a chorus, a second verse, a second chorus, a breakdown section, back into a double-length chorus and outro.[16]

[16] Cauty, Jimmy and Drummond, Bill, *The Manual: How to Have a Number One the Easy Way*, Ellipsis, 2001, p. 53.

Middleton's two kinds of repetition are instantly recognisable in the first and third "Golden Rules". In addition, a number of other standard practices are recommended. Each of the sections described in the third "Golden Rule" should be in groupings of multiples of four, so that, for example, the "intro" might be four bars, the first verse might be 16 bars.[17] The drumbeat must not be complicated; ideally it should contain a bass drum on beat one and a snare drum on beat three of a 4/4 bar. It is warned that no song over 135bpm will get to number one.[18] Lyrics should be kept to a minimum; verses can be "any old gibberish" (implying meaninglessness) but the chorus and song's title should contain something that will capture the attention of the record-buying public. Ideally, the title is contained in the lyrics of the chorus. But *The Manual* is more than just a list of pop clichés; it offers a Zen-like set of instructions (one of the book's chapters is titled "Causality Plus a Pinch of Mysticism"). Parallels can be drawn with Eno's *Oblique Strategies*, but Cauty and Drummond are somewhat less pretentious. In a day-by-day account, it explains how to conduct one's life while pursing the ultimate pop goal. Consequently, *The Manual* provides considerable leeway for interpretation, more so than might be expected from book that sets out to reduce popular music to a formula. It is based on contradiction; at one moment the authors insist that their instructions be followed to the exact word,[19] at the next, they suggest that the reader "fast forward – all the way to the end" should the book get too boring.[20] *The Manual* is presented to be as dismissible as it is essential and, viewed in its totality, is analogous to the three minute and twenty second pop single – both engaging and throwaway at the same time.

The Manual stresses that for a song to have any chance of making it to number one (the easy way) it must address the desires of the teenage demographic. In other words, the "Golden Rules" work by appealing to the primary musical desires of young listeners. *The Manual*'s archetypal teenage listener is in fact a substitution for what Adorno calls the "untrained" listener. Adorno argues that popular music must meet two demands: firstly, it

[17] Ibid., p. 63.
[18] Ibid.
[19] Ibid., p. 12.
[20] Ibid., p. 14.

must provide stimulation, and secondly, it must fall into the category of what untrained listeners would term "natural" music, defined as:

> The sum total of all the conventions and material formulas in music to which he [the listener] is accustomed and which he [the listener] regards as the inherent, simple language of music itself, no matter how late the development might be which produced this natural language.[21]

Cauty and Drummond do not refer to Adorno at any stage but seem to be aware of this argument. At one point they state that those who believe the popular music industry is founded on "demands being created and appetites stimulated" may as well never have been teenagers.[22] This sentimental portrayal of the naïve and impressionable listener as something to be cherished is un-Adornite. It is hardly surprising that a book all about having a hit single should oppose him, but by attempting to systemise pop music its authors are affirming him as much as they seem to be denouncing him. *The Manual* manages to turn Adorno's "negative" portrayal of chart music into a series of "positive" guidelines, where everything he singles out as being wrong with popular music is reinterpreted as the correct way to go about having a number one. Cauty and Drummond only make this reversal of value systems possible because they are not bothered that the "Utopian promise" (i.e., freedom) is missing from pop. This is exemplified by their first chart success, "Doctorin' the Tardis" which takes Adorno's idea of pseudo-individualisation to its logical conclusion: the reason the music is "pre-listened" is because it really *has* been heard before. The track consists of parts of Gary Glitter's "Rock 'n' roll", the "Doctor Who Theme" and The Sweet's "Blockbuster". From the listener's perspective, predicting which path a piece of music will take becomes a good deal easier when it has been experienced before.

Adorno uses the term pseudo-individualisation to explain why standardised songs do not sound exactly the same. As he sees it, pseudo-individualisation masks standardisation so that consumers believe they are experiencing something new. But the differences between

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[21] Adorno, Theodor, "On Popular Music", *Studies in Philosophy and Social Science*, New York, Institute of Social Research, 1941, IX, para. 19.
[22] Cauty, Jimmy and Drummond, Bill, *The Manual: How to Have a Number One the Easy Way*, Ellipsis, 2001, p. 23.

songs, the details that imply individuality, are actually conforming to a prescribed role. They do not break from the system; they merely alter how it is perceived. The naturalisation of song structures leads listeners to mistakenly interpret pseudo-individualisation as real change and thus removes their desire for fresh experience. In Beethoven and other art music, Adorno argues that the details of the music and its form are inseparable, each dependent on the other to produce a unique work. In popular music, however, the details and the structure are mutually exclusive; e.g., the chorus of one love song can be swapped with chorus of another without changing the essential meaning of the song. The underlying structure does not depend on the details; in fact, it is essentially "abstract": it goes unnoticed.

> The detail has no bearing on a whole, which appears as an extraneous framework. Thus, the whole is never altered by the individual event and therefore remains, as it were aloof, imperturbable, and unnoticed throughout the piece. At the same time, the detail is mutilated by a device which it can never influence and alter, so that the detail remains inconsequential.[23]

A similar point was made by Zappa, who once estimated that two of the most common chord progressions in rock 'n' roll, I, IV, V and I, II could be found in 15,000 songs.[24]

The third "Golden Rule" draws upon the standardisation of popular music, suggesting that the most suitable structure for a number one hit should be familiar and unchallenging to the listener. Four-bar phrase lengths play a part in this, but Cauty and Drummond identify a pseudo-individual device that introduces structural irregularities without being detrimental to the overall scheme.

> In some records there will be one or two bars stuck in between two of the sections where most of the music stops and a few bits are left hanging in the air before the whole track comes crashing back into the next section.[25]

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[23] Adorno, Theodor, "On Popular Music", *Studies in Philosophy and Social Science*, New York, Institute of Social Research, 1941, IX, para. 12.

[24] Frank Zappa, "Excerpt from the Uncle Frankie Show", *Mystery Disc*, 1998.

[25] Cauty, Jimmy and Drummond, Bill, *The Manual: How to Have a Number One the Easy Way*, Ellipsis, 2001, p. 84.

As a result of these so-called "hanging bits", difference is introduced at a structural level with phrase lengths becoming uneven to accommodate extra bars. The difference, however, is only minor and not the sort that affects the predictability of the music. The purpose of "hanging bits" is to prepare listeners for a change of direction, not confuse them. Like an unresolved cadence, they create a tension which, in the primary musical language Adorno associates with popular music, can only appeal to "untrained" listeners through resolution, i.e., meeting with their expectations. The chart below shows the structure of "Doctorin' the Tardis" in bar lengths:

Structure in sections	**Bars per section**
Intro (a cappella chorus)	10
Count in	1
"Blockbuster"	8
Hanging bit	2
Verse (double length)	
"Doctor Who Theme"	20
Chorus	
"Rock 'n Roll"	10
Post-chorus	4
Verse	10
Chorus	10
Post-chorus	4
Breakdown	
"Blockbuster"	12
Hanging bit	2
Chorus (double length)	20

Upon closer inspection it is revealed that Cauty and Drummond follow the "Golden Rules" strictly: the groove is continuous throughout, the song fades at three minutes and twenty seconds and the verse/chorus structure is adhered to. "Doctorin' the Tardis" disregards the lesser rules, for example, that all sections should be in multiples of four. This comes about because the section taken from the Doctor Who theme tune is ten bars long. Therefore, the expectation that verses and choruses might be eight or sixteen bars long is not met. But the extra bars merely repeat what has already been heard, and taking into account the familiarity of the Doctor Who theme music, the use of uneven phrase lengths is barely noticeable. The chorus, on the other hand, meets with the demands for simplicity (although it fails to include the title):

Dr. Who! (HEY) Dr. Who
Dr. Who! (HEY) The TARDIS
Dr. Who! (HEY) Dr. Who
Dr. Who doc..Dr. Who
Dr. Who doc..Dr. Who[26]

Pre-choruses act as bridges between verses and choruses, and may be found in many pop songs. A pre-chorus paves the way for the chorus, and if it works well sets up the chorus to enter with more impact. In this example there is, for use of a better expression, a "post-chorus", which seems to do the opposite, i.e., reduce the impact of the verse or emphasise the end of the chorus. It consists of call and response between a Dalek (an effect created by speaking through a ring modulator) and a group of male voices. They exchange the football chant "You wot?" and in doing so, confirm Cauty and Drummond's claim that meaning is not a prerequisite of pop song lyrics. Structurally, this could be an example of a "hanging bit" since much of the music drops out at this point, but at four bars long it qualifies as a section in its own right.

To summarise, in "Doctorin' the Tardis" samples are not manipulated to create new sounds. Instead they are part of a satirical take on the standardisation of chart music. In an attempt to reduce pop music to a simple formula, the samples are looped by way of standardised uses of musematic repetition. Cauty and Drummond's use of discursive repetition is also designed with predictability in mind, a factor which is emphasised by the familiarity of the samples. Decisions are carried out according to the "Golden Rules", leaving some details open to potential randomisation, for example, Cauty and Drummond argue that the words of verses can be practically anything ("any old gibberish") as long as the chorus appeals to a large audience demographic. This echoes Adorno's idea that "detail has no bearing on a whole" (see page 183). The following section examines a rather different approach.

[26] The Timelords, "Doctorin' the Tardis", 1988.

5.2.2 "Plunderphonics"

The Canadian composer John Oswald uses the expression "plunderphonic" to describe the central element of his compositional work, essentially, the appropriation of pre-existing sound sources. A "plunderphonic" is explicitly concerned with the use of pre-existing musical materials to create something new. This contrasts with Cauty and Drummond who, for example, do not change the "Doctor Who Theme" into anything new; they use it for the qualities it already possesses and its familiarity/immediacy (in the UK it is an instantly recognisable tune). In "Doctorin' the Tardis" the source materials are recontextualised, but lose few of their original characteristics.

Oswald purposefully samples pre-existing music, defending against accusations of plagiarism by referring to Milton's argument that plagiarism of a work only occurs "if it is not bettered by the borrower".[27] In view of restrictive copyright laws designed to protect the financial interests of those involved, Oswald argues the case for "audio piracy as a compositional prerogative", so long as sources are referenced.

> Professional developers of the musical landscape know and lobby for copyright. On the other hand, many artistic endeavours would benefit creatively from a state of music [...] where, as in scholarship, acknowledgement is insisted upon.[28]

Accrediting an artist is easy enough, but gaining permission to sample music presents a more difficult challenge. As a consequence, Oswald's "plunderphonics" have led him into legal disputes. The cover of his first album *Plunderphonic* (1989) doctors Michael Jackson's *Bad* (1987) album sleeve, superimposing Jackson's head and leather jacket on the body of a naked white woman. In doing so it represents the collage strategy of the music on the record. The track called "dab" (attributed to Alien Chasm Jock) is a "plunderphonic" of Jackon's song "Bad". Not surprisingly, Sony complained to the

[27] Oswald, John, "Plunderphonics, or Audio Piracy as a Compositional Prerogative", as presented by John Oswald to the Wired Society Electro-Acoustic Conference in Toronto in 1985. http://www.plunderphonics.com/xhtml/xplunder.html
[28] Ibid.

Canadian Recording Industry Association and a ban was eventually ordered on the record being distributed, despite Oswald insisting it was a "not-for-profit" release and Sony's lawyers failing to prove that he had actually done anything wrong. It is possible *Plunderphonic* would have met with less resistance from the record industry had it set out to flatter the egos of those it plundered rather than make fun. Using Jackson's music as building material was cheeky, but turning him into a white female was getting personal.

The use of Jackson's image and the treatments applied to his music indicate a subversive agenda behind Oswald's choices of source material. From the point of composition, "dab" is like a polemic on predictability aimed at the use of repetition in popular music. It is as if Oswald is answering the question "what happens if you repeat these sounds like this instead"? He is not interested in standardised structures, although a sense of the song's original structure remains; the verse and chorus can still be detected in spite of the many layers of processing. Nonetheless, "dab" takes an unpredictable course, like a piece of free improvisation.

> Back in Beethoven's days they tended to put repeats of the themes and all that stuff in, because it was quite likely that someone was only going to hear it once it their life. [...] It's absolutely not necessary now, because you can just play a record over and over again.[29]

Although Oswald abandons the use of repetition at a discursive level, it is prominent at the level of the details, so that a sense of structure is achieved through musematic repetition, rather than alternating patterns of verse/chorus or ABAB. Through the use of echo and delay effects, he creates a new soundworld from the musematic repetition of short sounds, many of which are derived from Jackson's singing voice. Percussive effects and "psychedelic" transformations are created from small pieces of Jackson's vocal repeated through thousands of shifting loops.[30] Through the constant, musematic repetition of the word "bad", the word "dab" emerges. This also has structural implications. Jumpy repetitions like those caused by scratches on a record result in Jackson getting stuck on his

[29] Keenan, David, "Undoing Time", an article about John Oswald, *The Wire*, Issue 219, 2002, p. 46.
[30] Ibid., p. 44.

words. At one point, in a moment reminiscent of a William Burroughs cut-up, Jackson is made to sing the line "Your butt is, butt is love".

Oswald's "plunderphonics" and Cauty and Drummond's "Golden Rules" both incorporate sampling techniques but in very different ways. In some respects, they are polar opposites. Cauty and Drummond create musematic repetition out of samples, as if to emphasise chart-orientated popular music's naturalisation. Oswald often uses sampled materials to generate singularities, moments that are never repeated. Cauty and Drummond want their source material confined within a recognisable structure and apply discursive repetition, whereas Oswald wants to liberate the sounds of pop and therefore (with a few exceptions) rejects the use of standardised forms, which depend heavily on discursive repetition. This can result in pieces of unpredictable form. Cauty and Drummond never loose sight of the importance of repetition in pop music; it is used both structurally, as alternations between verses and choruses, and within the details. The materials used by Oswald undergo treatments that remove them so far from their original context that they create their own identity, described as "the construction of music anew in the act of deconstructing it".[31]

What follows is a discussion concerning the "bootleg" genre. This takes many of its techniques from *Plunderphonic* but uses them within familiar song structures, based on musematic and discursive repetition.

5.2.3 The Bootleg Genre: A Synthesis of the "Golden Rules" and "Plunderphonics"

Popular music has diversified greatly since Adorno wrote *On Popular Music*, but it is still true that with each new musical discovery comes a wave of imitations; innovation is quickly assimilated into mass-market spin-offs. In recent years, "bootleg" has emerged as a

[31] Keenan, David, "Undoing Time", an article about John Oswald, *The Wire*, Issue 219, 2002, p. 43.

genre on the edges of popular music, owing many of its techniques to those pioneered by the likes of Cauty and Drummond, and Oswald. As with each of these examples, the original sound source of a bootleg track is usually familiar to a pop audience, but what tends to differ is how this source is treated. Whereas "plunderphonics" have the power to set the source material free from its musical and cultural setting (e.g., we get the sound of Michael Jackson without the commercial appeal) bootlegs are aimed towards a more popular market. When Britney Spears's voice was placed over a hip-hop track by Eminem to satirise the apparent rivalry between the two pop-stars, the result was unashamedly aimed at the MTV generation. The track lacked the sense of compositional awareness that Oswald's "plunderphonics" strive for, preferring instead to reinforce standardised uses of musematic and discursive repetition.

The bootleg phenomenon coincides with the increased availability and affordability of digital technologies, which have made it possible for home users and amateur musicians to produce their own music. Traditionally, a "bootleg recording" was an unofficial recording of a live concert, usually made by a fan and distributed by way of underground, unofficial fanzines. It differs from piracy because it does not deal with the duplication of official releases. The basic concept behind the "bootleg genre" is different in that it does duplicate official releases, but it again differs from piracy because it utilises creative sampling and editing techniques. There is also no restriction on which artists are used on a bootleg. The act of appropriation is familiar to both hip-hop and bootleg, but whereas hip-hop samples the back-catalogue of Afro-American music, bootleg takes from the present. It sources new/recent chart releases, novelty records, the "next big things" for its material, often with a sense of irony.

In spite of their radical roots in the music of Oswald, most bootlegs exhibit signs of standardisation and pseudo-individualisation, since they adhere to familiar song structures and titillate with humorous juxtapositions. A good example is the track "I'm Out of My Mind and Bacon Rind" by V/VM. It is a scurrilous attack on the first solo release by ex-Spice Girl Victoria Beckham and works by applying (among other things) ring modulation, pitch shifts, time stretches and unpredictable editing to the track. V/VM at least have the right motive; they are not simply combining different pop songs. Like Oswald they approach popular music as a source of sounds. V/VM prove that when carried out with skill, bootlegging can provide the listener with a listening experience filled with unexpected and unpredictable twists and turns, a kind of unpredictability based on the distortion and exaggeration of musical clichés, much like a grotesque caricature. Such is the nature of pop music to "all sound the same" that it is possible for a bootleg recording to make funny musical observations by cutting from one artist to another to see if anyone notices; this is a satirical use of materials, organisation steered by a sense of humour. Although the process of creating a bootleg has more to do with the possession of adequate editing skills and a good ear for synchronicity than the traditional skills of a composer – it is a process of composition nonetheless. The techniques of image montage (cutting and pasting to name the most obvious) also apply to bootleg music.

The forerunners to V/VM might be Culturcide, the American punk band who released *Tacky Souvenirs of Pre-Revolutionary America* (1987), an album featuring their own cynical lyrics crooned over official chart releases, an action best described as Dada karaoke. Like Oswald's *Plunderphonic,* Culturcide's record was immediately banned. One of the songs they choose to "enhance" was the American Band Aid song "We Are The World". Their version sent out a slightly different message:

> Well, buy the record so they can pretend they care
> And there careers will be stronger and guilt free
> As Michael and Lionel have shown us, the world is just TV
> If children are starving, let 'em drink Pepsi![32]

What is interesting about Culturcide is that they (like Cauty and Drummond, and V/VM) seized upon the idea of using sampled material to make a satirical point, taking it to a ridiculous extreme. Rather than loop a few seconds of a song, Culturcide sampled the entire track. They did not need to apply any "Golden Rules" because the song's entire

[32] Culturcide, "They Aren't The World", *Tacky Souvenirs of Pre-Revolutionary America,* 1987.

structure was laid bare before them. Culturcide's method of working allowed them to satirise popular music in a highly amusing and controversial way but they were also commenting on predictability, the "sameness" of popular music, achieving a critical stance by creating something unexpected, crude and unappealing to the mass market.

5.3 THE INCORPORATION OF QUASIORDER IN POPULAR MUSIC COMPOSITION

The next section discusses three methods of producing quasiorder and investigates how riff units can be randomly generated but perceived as ordered due to structural predictability. The first method is for a musical group, and the second and third methods involve a computer program called *MAX*. The goal of each of these is to generate unpredictable units of repetition. In the group pieces, this is achieved using a colour-coded score-based system designed to signify the repetition of three or four indeterminate pitches within the riff unit. Limitations emerge; rhythm is fully composed as are the musematic and discursive repetitions. The first computer-based system resolves this problem with the aid of a random riff generator. In this system, each riff unit contains randomly generated pitches and rhythms. Musematic repetition is also randomised, so that the duration of each riff is unpredictable. This creates an equally unpredictable structure, like that caused by the use of musematic repetition in Oswald's "Dab". In the second computer-based system, riffs (randomly generated as before) are used within the structural framework defined by Cauty and Drummond's "Golden Rules", with the intention of creating a quasiorder pop song. To achieve a further level of quasiorder, the infinite-monkey theorem is used to define the discursive repetitions of the random riffs. Quasiordered lyrics are generated in line with Adorno's theory that the details of popular songs are interchangeable.

5.3.1 Coloured Dots Process: A Score-based System for Generating Riffs from Random Seed Pitches

Colour coding can be used to indicate the repetition of seed pitches chosen at random. It provides a way for a group to create and control random musematic repetition when playing. A basic coloured dots score contains rhythm information with three or four colours indicating different pitches. These colours also encode melodic repetition. As the score is played, each musician has to decide which pitches the colours represent, and stick to those pitches until the end of the repeated section, when a new set of seed pitches may be assigned. With four musicians playing a score founded on this procedure, the chance of ever repeating a performance is unlikely (although at increased tempos musicians tend to go for patterns they are familiar with, rather than take risks which might not be successful). Harmony is the most noticeable parameter to be affected, with chords constructed from pitches chosen freely.

In the first example (*CD 1*, track 10, with score on page 285), the fixed discursive repetition takes on a familiar verse-chorus form using a bridge (or ABABC form). The musematic repetition moves along in multiples of four bar phrases and rhythmically is extremely simple. The music can be for any selection of instruments; here it is arranged for a rock band (guitar, keyboard, drums and bass). Each of the four musicians has the same selection of coloured dot patterns, of which there are nine in total, labelled alphabetically from A to I. These patterns are divided between three main sections: verse, bridge and chorus (see page 286 for a comparison of the guitar and keyboard parts), which are repeated throughout. Despite the riff units themselves being arrived at by way of an aleatory process, the use of a common structural device means the listener experiences no difficulty in predicting when the changes will occur.

The second coloured dots piece (*CD 1*, track 11, with score on page 288) contains more structural variation. Once again, the four musicians each use the same selection of patterns, in this case labelled from A to L. The piece is divided into six sections where the numbers following each letter indicate the number of times each pattern is repeated (see page 289). Hyphens indicate "play nothing" – a period of silence lasting one bar. Again, the idea that sections of the music should move in multiples of four is prevalent, but shorter sections are also used to counter this predictability. Pattern K distinguishes itself from the rest since it is the only pattern which relates to specific pitches. As with fixed pitches used in Zappa's "Approximate" the effect of these notes is to provide moments of tonal stability. Through the use of repetition and the sound of amplified instruments both pieces sound like rock music, but the treatment of pitch goes beyond that.[33]

In the same manner as the previous chapters, *figure 5-1* attempts to show the relationship between process and perception. Here, a continuous supply of randomness is required throughout the piece as each section requires a new set of pitches and this accounts for its position along the x-axis. Control, indicated by the y-axis, is also substantial, with rhythm and structural aspects defined by the score. As for the perception of randomness, this may be detectable, but a sense of order prevails due to the presence of repetition.

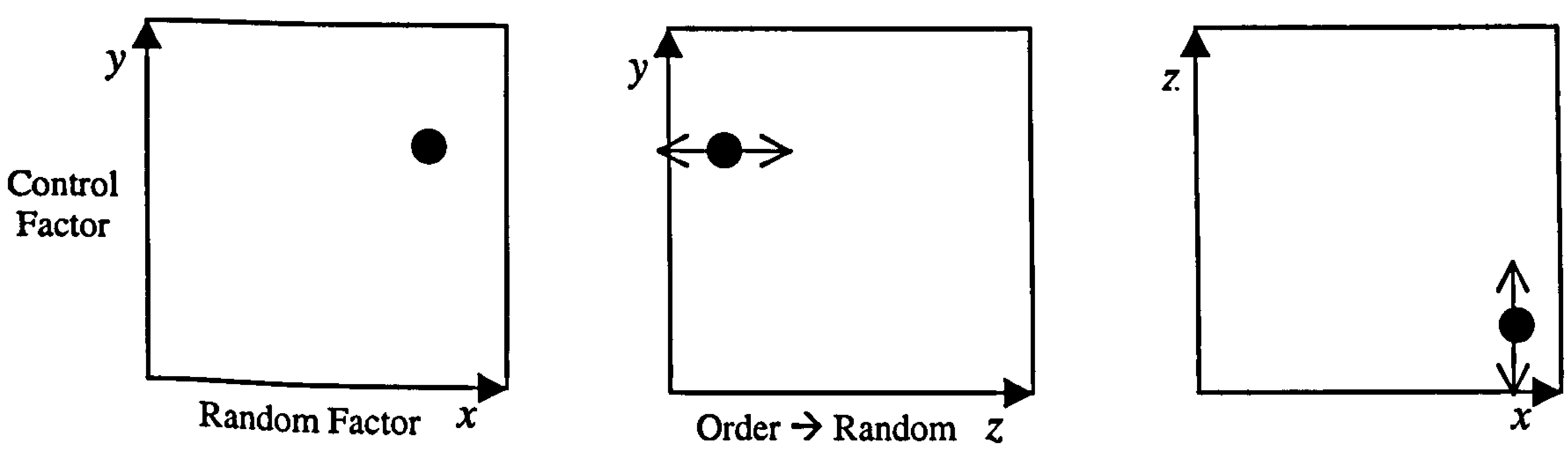


Figure 5-1: Degrees of randomness and order, in process and perception, in Coloured Dots I *and* II (CD 1, *tracks 10 and 11*)

[33] It is actually possible to simulate this technique on a common sequencer using transposition maps, which substitute one set of pitches for another. In a piece of music, therefore, the pitches can be changed whilst leaving the rhythms and patterns of repetition intact.

One of the problems with this method of generating unpredictable riffs is that, over time, musicians tend to gravitate towards certain melodic patterns or shapes. This reduces the number of possible note combinations, altering the degree of unpredictability that can be experienced. The following method overcomes this problem through the use of a computer.

5.3.2 A Computer-based System for Generating Random Riffs

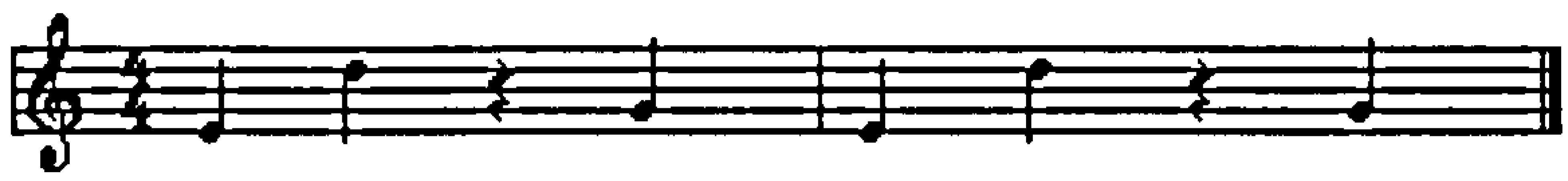
Max is a MIDI software package used in the creation of algorithmic compositions by way of a collection of pictorial commands called "objects". With these objects, the user can design "patches", gaining a much higher degree of control over MIDI data than is possible with the standard sequencer.

As Middleton has pointed out (see page 176), there are many different kinds of riff. In order to generate musematic repetition randomly in a computer environment, it was necessary to consider some basic riff criteria. Attempts were made to accommodate the following characteristics:

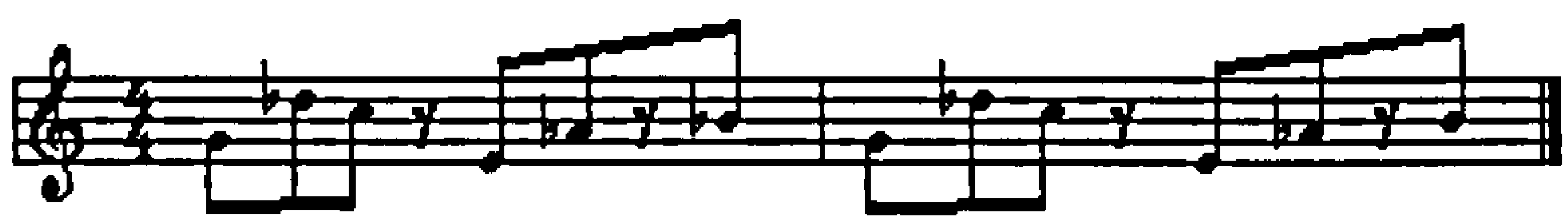
1) The minimum number of riff repeats (the unit of repetition) must be large enough to establish repetition, i.e., each riff unit must be performed at least twice to qualify as a riff.
2) The maximum number of riff repeats must be within the listener's boredom threshold (in this example, a maximum of four repeats is considered adequate).
3) The system must do more than simply repeat a stream of randomly generated pitches; there must be some control over the random selection.

This final point requires some further explanation. One of the appealing aspects of the aforementioned "coloured dots process" is the way that pitch repetition and non-repetition is encoded by the various colours. From a compositional perspective, the following rule of thumb seems reasonable: the greater the number of notes within the unit of repetition, the more desire there is to place a degree of control on the number of different pitches that can occur. This lends the riff a more composed sound rather than sounding completely unpredictable. Consider the three randomly generated riffs below, where the basic note value is halved in each example:

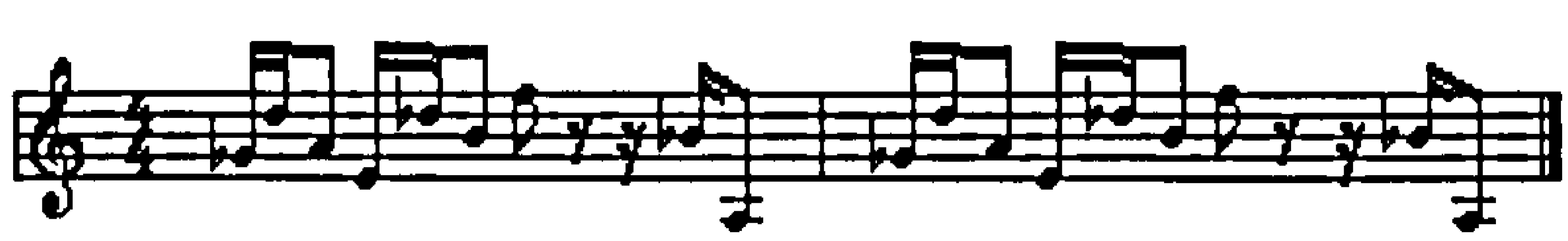
Riff 1: Randomly generated crotchet notes and rests.



Riff 2: Randomly generated quaver notes and rests.



Riff 3: Randomly generated semi-quaver notes and rests.



In these examples, the riff unit is one bar long. The number of random notes per riff unit has a strong influence on the musical syntax. The first riff is extremely simple and easy to memorise, since there is no rhythmical complexity and the melody lies within an octave. It does not possess the characteristics that one might associate with randomness; however, it could also be argued that it is not very interesting. By increasing the number of random notes per bar the riff unit begins to sound more appealing. The second riff is slightly more varied rhythmically but the pitch choices (and resulting intervals) are rather unusual for pop music. Despite this, it is still possible to think of them in a harmonic sense. The first two notes form a diminished fifth and those that follow are components of a whole-tone scale.

The final riff has the most interesting rhythm but because there are more random pitches it is much harder to think of the riff in terms of traditional harmony. In this final example, it is clear that as the number of notes increase, the melody begins to sound more random. A more standardised (and one could argue more commercially viable) riff can be achieved by limiting the number of random pitches while retaining the rhythm.

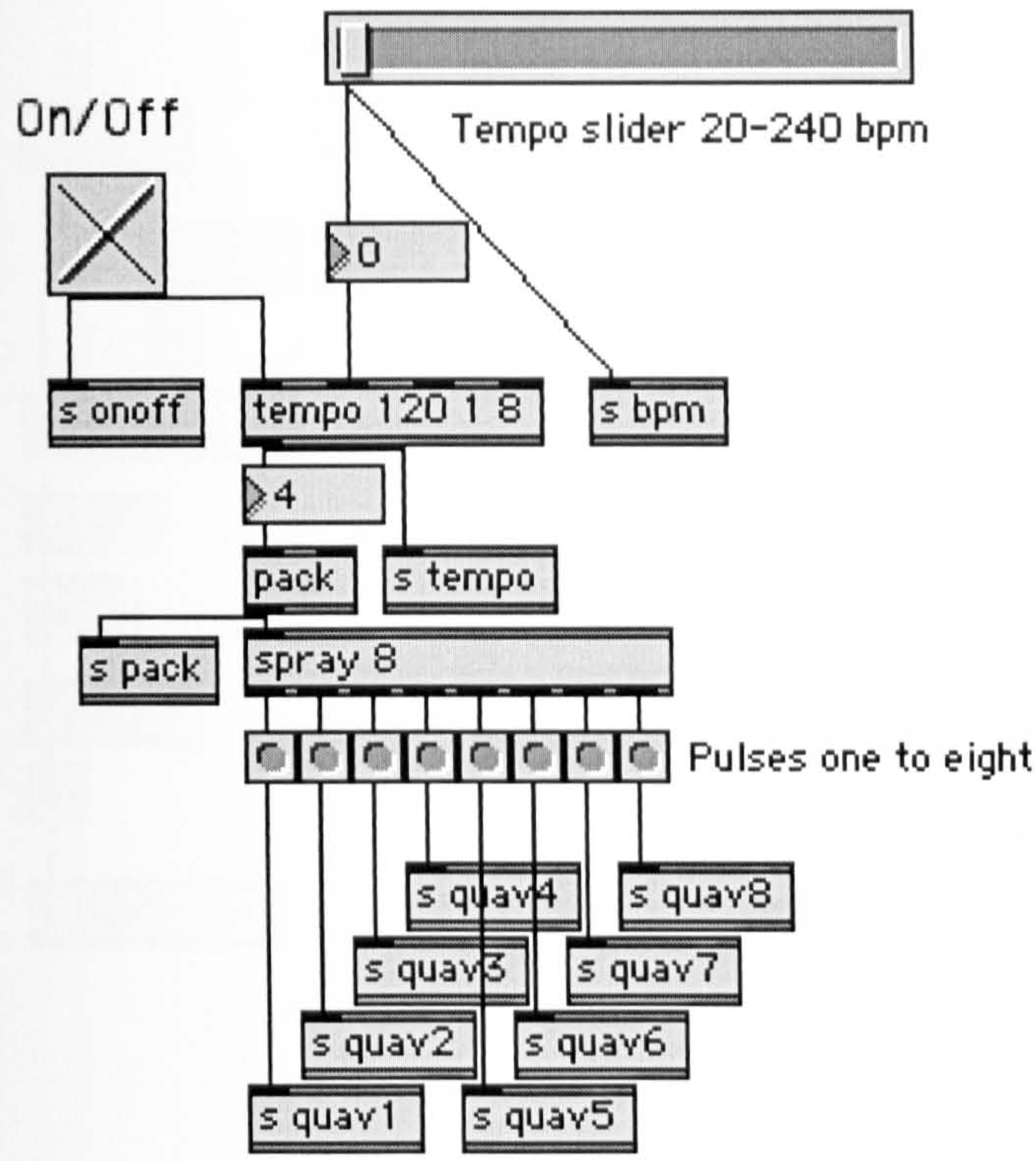
The random riff patch works by randomly generating units of repetition from a range of pitches. Repeating each of these a random number of times produces the riffs. How this is carried out in *MAX* is less obvious and requires further explanation. The process can be divided into the following five sections: Metronome, Bar Counter, Pitch Generator, Pitch Router and Random Play/Rest. The role of each of these is discussed below.

1. Metronome

Owing to much of popular music's dependence on repetitive riffs and grooves traditionally placed around dance beats, dramatic and unpredictable tempo variations are uncommon. This section of the patch was initially set up to change to a random tempo at the start of each new riff. This increased the level of unpredictability but caused the music to sound less standardised and so the approach was abandoned. The Metronome not only controls tempo, but also counts the number of beat sub-divisions in each bar. Popular music favours 4/4 time signatures. It was therefore desirable to produce riffs in 4/4 (although in later trials, riffs in compound and irregular time signatures were created).

The number of possible notes in each "riff unit" was determined by the number of beat sub-divisions. The version of the metronome pictured below (see *figure 5-2*) was designed to produce eight quaver pulses. In a later version, this was changed to produce 16 semi-quaver pulses, adding more detail to the rhythm of the generated riffs. Of course, not all riffs are one bar repeats. Many are based on two bar repeats (e.g., Led Zepplin's "Whole Lotta Love" and the Sex Pistols' "God Save the Queen") and even four bar repeats (e.g., Led

Zepplin's "Rock 'n' Roll"). A crude way of achieving the feeling of two and four bar riffs is to adjust the tempo slider to a slower setting.



The "tempo" object is preset to produce pulses at 120 bpm, but the slider with can be used to vary this.

The "spray" object produces eight pulses from left to right, which correspond to eight quaver pulses.

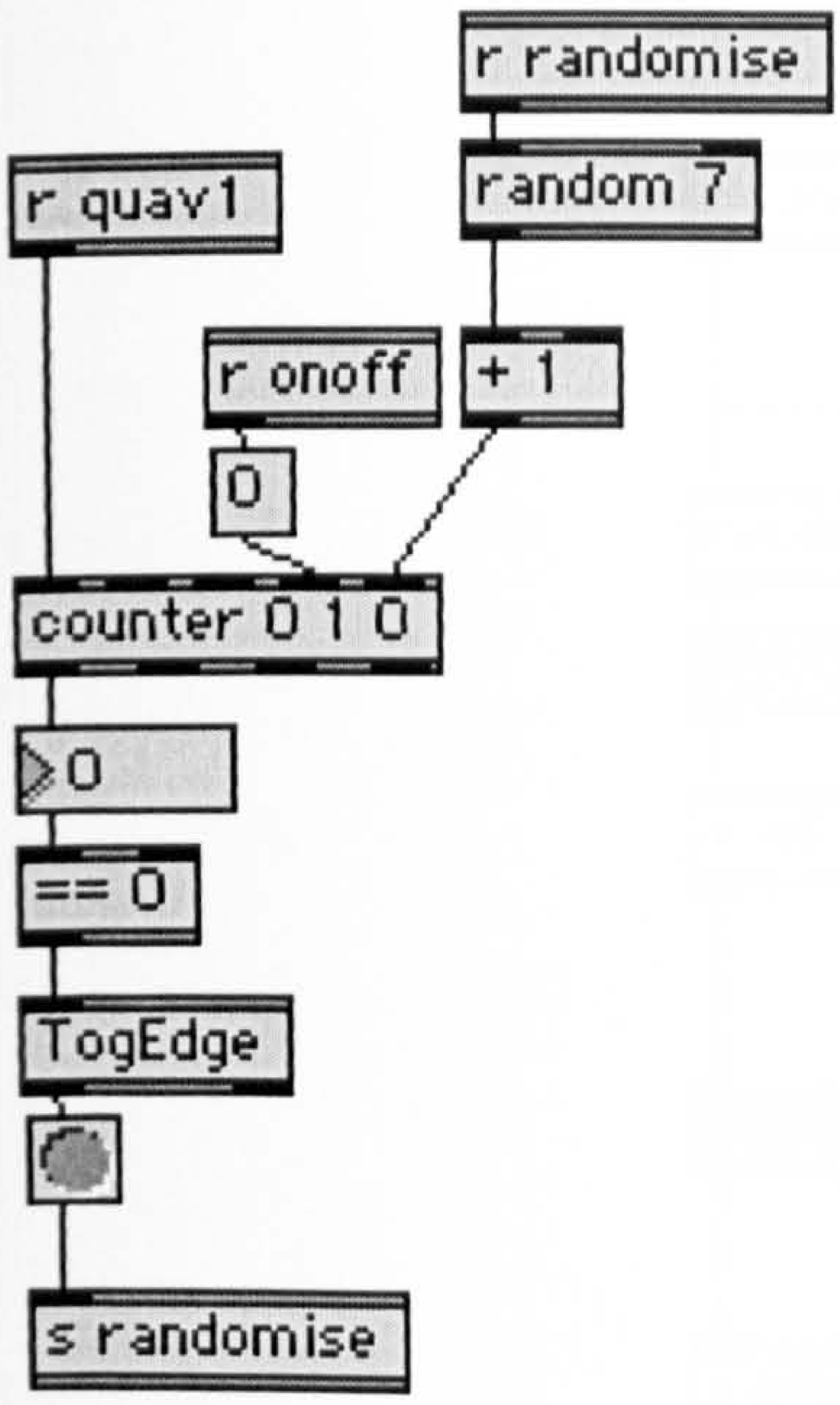
These pulses are sent to other sections of the patch to trigger certain events, as shall be explained.

Figure 5-2: Metronome Patch

2. Bar Counter

This section tackles the first and second riff criteria listed above (see page 194). The Bar Counter generates a random value for musematic repetition, determining how many times a riff unit is played. Within each cycle, the random object generates a number in the range of zero to three to determine the maximum count; upon reaching this value, the counter returns to zero and the whole process begins again. The upper limit placed on the amount of musematic repetition that can occur is set deliberately low for demonstration purposes.

Also, the absence of any overall compositional structure, as would be found in a son, removes the need for longer repetitions, keeping it within the listener's boredom threshold.



A message sent from the on/off switch triggers th generation of a random maximum count value. Upor reaching this value (which represents the amount ol musematic repetition that will occur) the "counter" object returns to zero.

The output of the zero comparator is zero at all times except when its input equals zero, when it outputs a one. The "TogEdge" object only produces a one from its left output when its input equals one. When this occurs a new maximum count value is generated and the process repeats.

Figure 5-3: Bar Counter Patch

3. Pitch Generator

This section of the patch (see *figure 5-4*) concerns the third criterion, that the random riff should sound non-random, i.e., quasiordered. This is achieved by limiting the number of possible pitches to four. To an extent this number is arbitrary; as with the maximum value for possible musematic repetition, it is chosen for demonstrational purposes. Four random numbers from within a random range of zero to thirty-five (i.e., potentially three octaves) are generated. A shift of forty-six is applied to each so that they occupy the mid-range of the MIDI keyboard. These values are then sent to the Pitch Router (see *figure 5-5*).

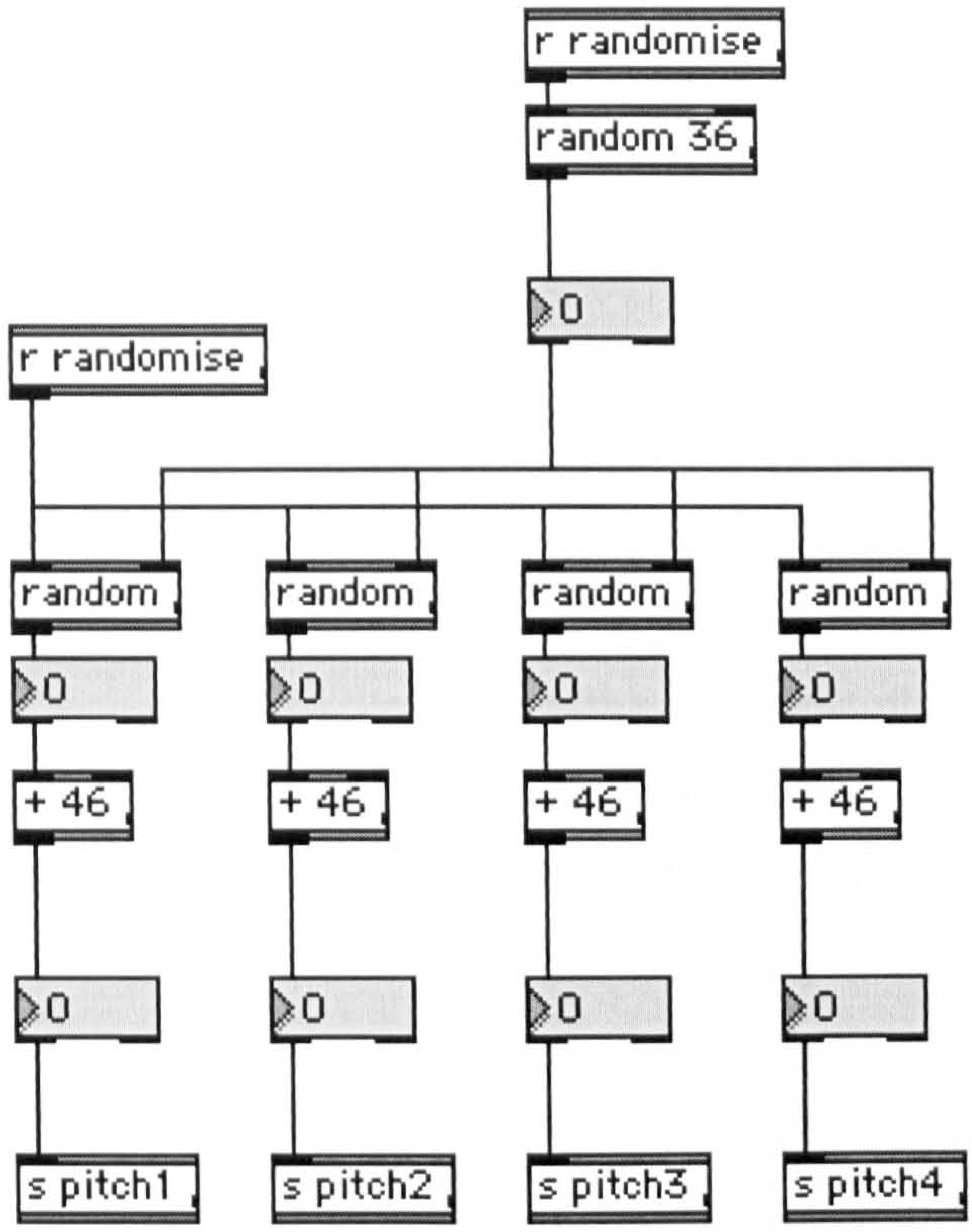
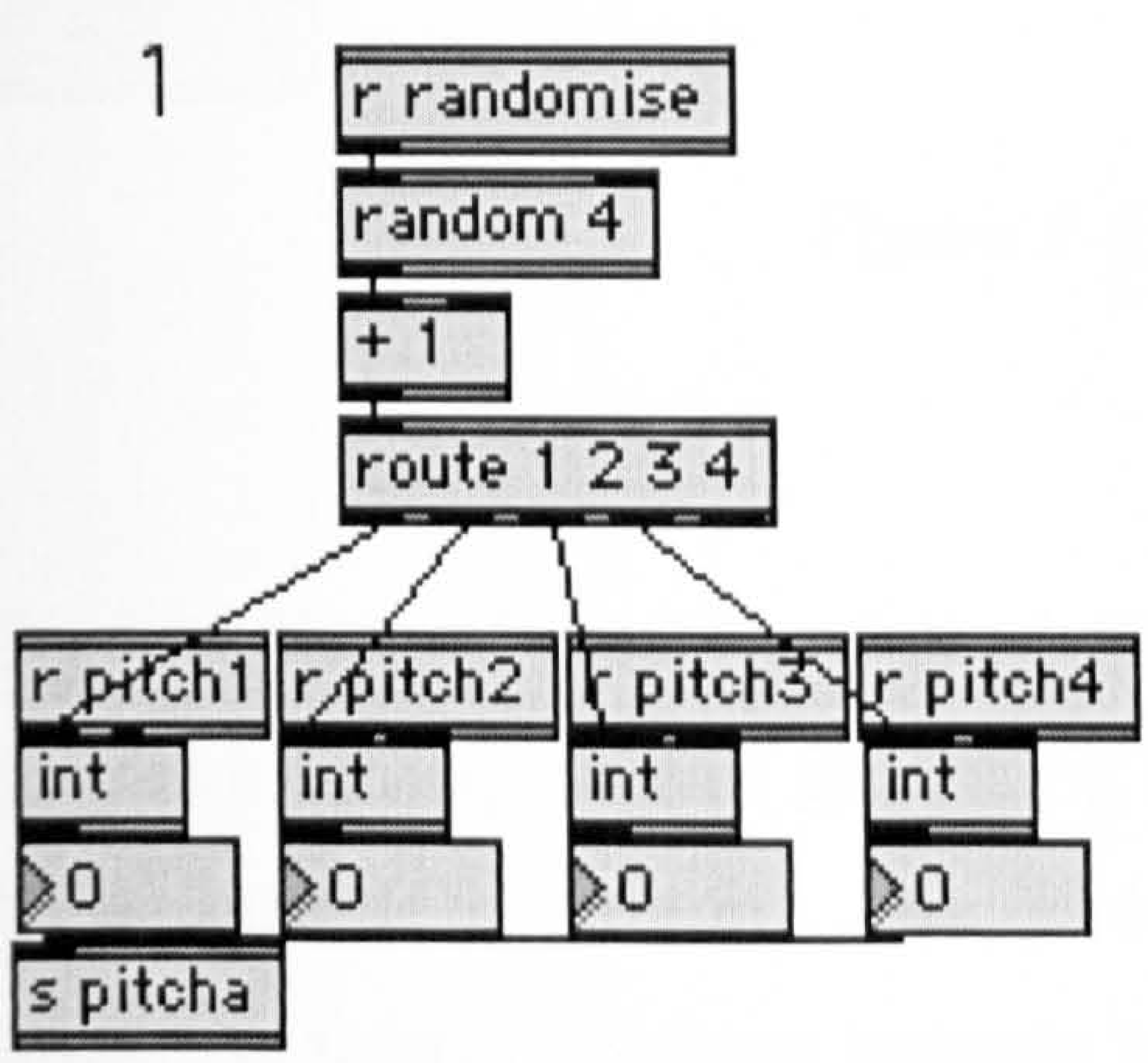


Figure 5-4: Pitch Generator Patch

4. Pitch Router

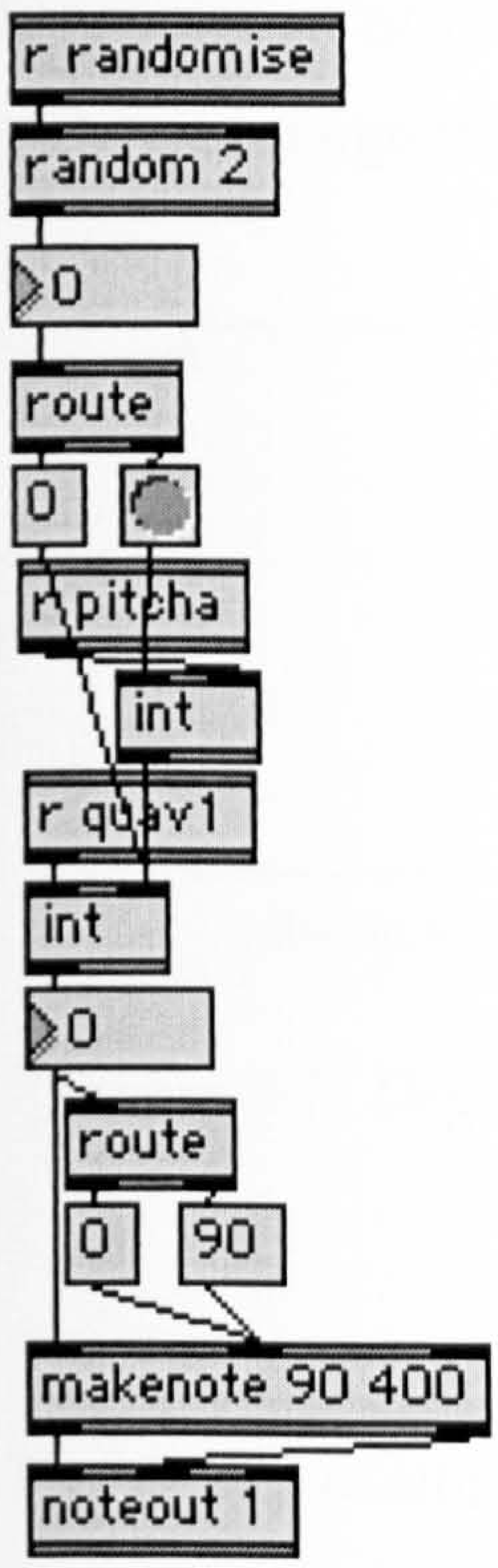


In total there are eight Pitch Routers like the one pictured in *figure 5-5*. Each one randomly selects one of the four pitches produced by the Pitch Generator. A random number, or argument, in the range of one to four is generated.

Figure 5-5: Pitch Router Patch

The "route" object then matches this argument with its own arguments (also one to four), producing a "bang" signal from those that agree. This is used to select which of the four pitches from the Pitch Generator is sent to Patch 5. On every complete cycle of the Bar Counter, one of these four notes is selected at random by each of the eight modules above.

5. Random Play/Rest



This patch assembles the riff. Whether or not a pitch gets played is determined by a random binary selection made by eight modules like the one shown in *figure 5-6.* A zero choice sends a velocity zero signal to the "makenote" object causing it not to sound when its turn comes. A one indicates that a pitch chosen by the Pitch Router will sound. The metronome pulse triggers these responses from left to right (quav 1 to quav 8).

Figure 5-6: Random Play/Rest Patch

The first piece of music generated this way (*CD 1*, track 12) provides a good example of how, as a consequence of generating random riffs, a random structure is also generated by the musematic repetition. The random unit of repetition is repeated two, three or four times. An interesting thing happens to the sense of randomness, which shifts from the riffs themselves (which sound less random because they are repetitious) to how each riff is perceived against its neighbours; for example, on some occasions, several different riffs may form a common harmonic progression, on other occasions they may remain static or move extremely erratically. The system could be elaborated to incorporate discursive types of repetition. By storing randomly generated riffs in a memory bank, the system could be programmed to refer to this memory and retrieve past riffs to create a sense of repetition at a structural level. *Figure 5-7* shows how the riffs may be perceived as being primarily ordered, in spite of being randomly generated. A minimal degree of control (*y*-axis) and large amount of randomness (*x*-axis) operate in such a way as to create easily identifiable patterns through the use of musematic repetition (*z*-axis).

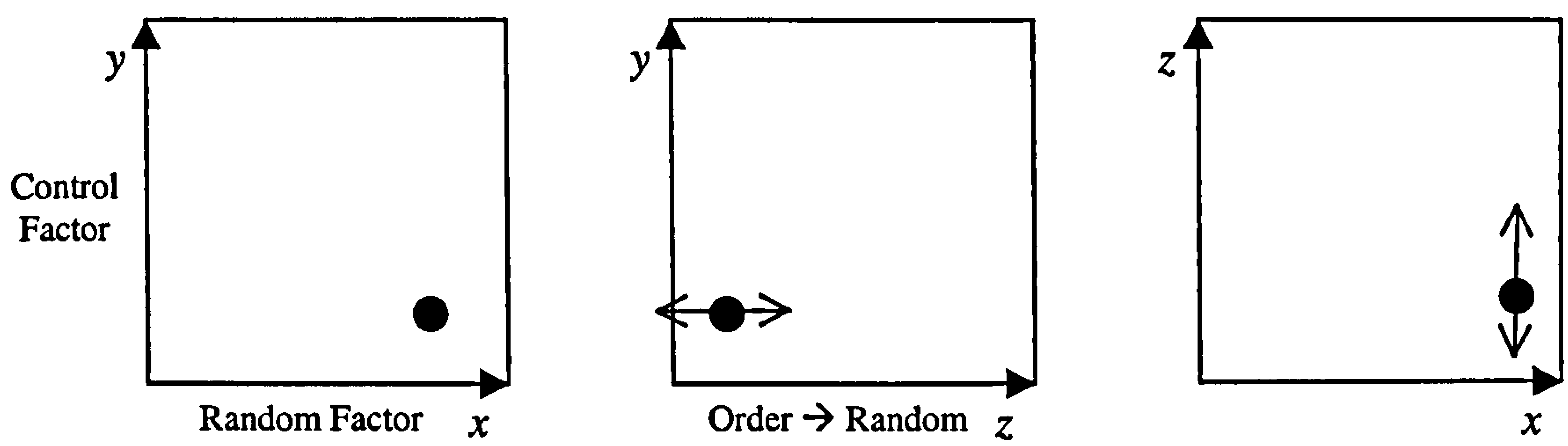


Figure 5-7: Degrees of randomness and order, in process and perception, of the example Random Riff I (CD 1, *track 12*)

The second example (*CD 1*, track 13) is based on a modification made to the metronome to generate sixteen semi-quaver pulses instead of eight quaver pulses. It works like an automated version of Riley's *In C*, but with randomly generated units of repetition. Each of the four instrumental lines (marimba, vibes, drums and bass) were generated separately and then superimposed. The bass and drums were performed at half speed to create further rhythmic variation. This means there are three random instrumental lines playing at once, each with its own random musematic repetition. As a result, the beginnings and endings of newly generated riffs often overlap.

Referring back to the three-dimensional representation shown in *figure 5-7*, this second example would reflect similar features, except that it may be perceived as more random, causing the point along the z-axis to take up a more central position. A comparison can be made with the group pieces, which are indeterminate throughout and controlled by relatively simple processes. They make use of musematic repetition in a fairly standardised manner (repeats occurring in groups of four), but discursive repetition is somewhat inconspicuous, existing as rhythm, but not as pitch. In the computer pieces, this unpredictability is extended to the number of musematic repeats (of which there is at least one for every randomly generated riff unit).

5.3.3 Creating a Quasiorder Pop Song

This section investigates a method of creating a quasiorder pop song (*CD 1*, track 14), drawing on a number of ideas discussed in the previous sections. Musematic and discursive forms of repetition are both randomly generated, with Cauty and Drummond's approach to structure used in conjunction with the infinite-monkey theorem.

Method

First, two four-bar units of repetition (A and B) and one two-bar unit of repetition (C) were created (see *figures 5-8, 5-9,* and *5-10* on page 203) using the random riff generator. As with the previous examples, these included drum parts and a basic harmonic accompaniment derived from the random pitches of the riff. A chance procedure was used to determine how the riffs would be assigned; this decided that A and B would constitute the riffs used throughout the verse and chorus sections respectively, with C reserved for the remaining sections, i.e., the intro, the outro and the breakdown. By addressing the two types of repetition identified by Middleton separately, it was then possible to randomly generate the structure of the piece.

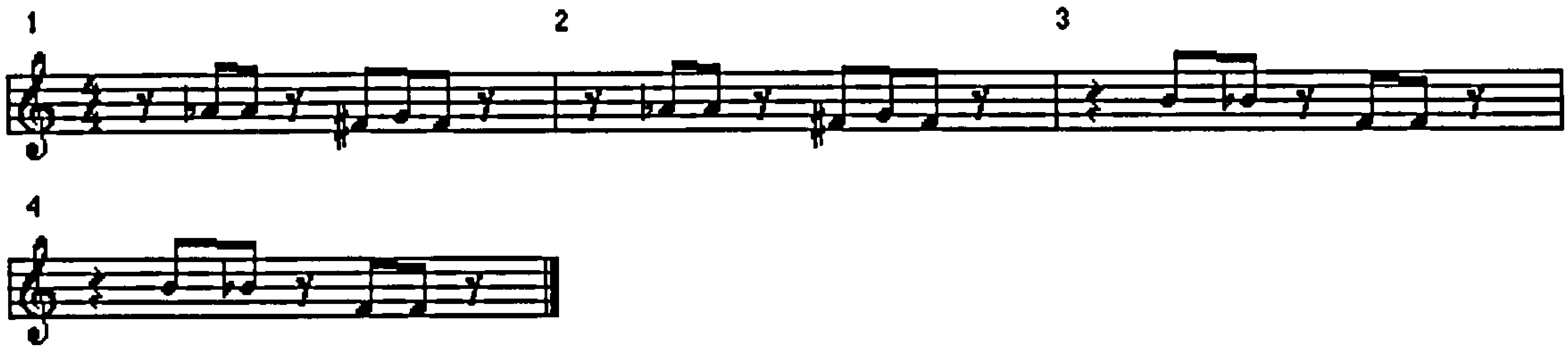



Figure 5-8: Riff unit A, used throughout choruses

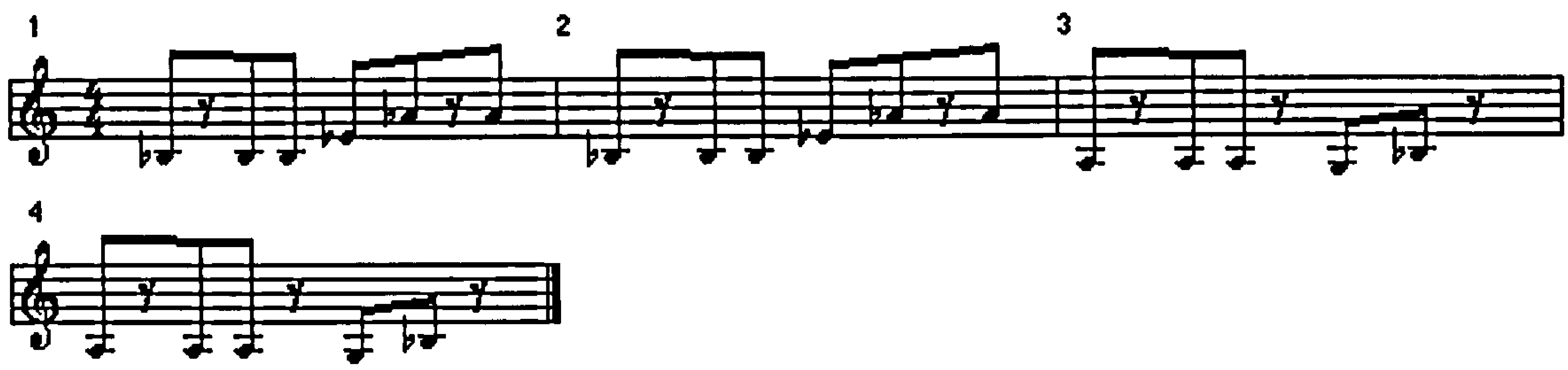


Figure 5-9: Riff B, used throughout verses

Figure 5-10: Riff C, used for intro, outro and breakdown sections

Discursive repetition was determined by flipping a coin a total of fifty times, producing the following set of outcomes (heads = H = A/verse, tails = T = B/chorus): THHTHHHTTHTTHTTHTHTTHHHTTTTHHHTHHTHTHHTHHHTTTHHTH. From this, a section was chosen (applying the infinite-monkey theorem) that best matched the formulaic structure specified in *The Manual* (see page 180), i.e., THTHT = BABAB = chorus 1, verse 1, chorus 2, verse 2, chorus 3. Although this begins with the chorus, and therefore differs from that specified in *The Manual*, it is still a familiar pattern of discursive repetition. A decision was made not to randomise the intro, outro and breakdown sections, which were deliberately positioned in line with *The Manual's* "Golden Rules". The complete structure of the piece was therefore: intro, chorus 1, verse 1, chorus 2, breakdown, verse 2, chorus 3, outro. Musematic repetition[34] was applied so that, given this structure, the song would last approximately three minutes at a tempo of 120bpm (again, in line with *The Manual*), i.e., ninety bars long. The pattern used to determine musematic repetition was selected (once again, using the infinite-monkey theorem) from the same set of coin flip results used previously (H = play twice, and T = play four times): THHTHHHTTHTTHTTHTHTTHHHTTTTTHHHTHHTHTHHTHHHTTTHHTH. The pattern HHTTTTTH was taken from this, producing the factors of musematic repetition as shown in *figure 5-11*:

Structure	Unit of Repetition Name	Bars	Musematic Repetition Factor	Total Bars
Intro	C	2	2	4
Chorus	B	4	2	8
Verse	A	4	4	16
Chorus	B	4	4	16
Breakdown	C	2	4	8
Verse	A	4	4	16
Chorus	B	4	4	16
Outro	C	4	2	8

Figure 5-11:Musematic Repetition

Other selections could have been made, but when applied to the structure this one produced enough material to last only slightly over three minutes. Musematic repetition was generated so that the verses and choruses could last up to either eight or sixteen bars, thus satisfying *The Manual*'s specification that sections comprise multiples of four bars in 4/4. Minor adjustments were made to incorporate "hanging bits", e.g., at the end of the first verse, where the last two beats of the music are silenced. Because these usually occur at the ends of sections, it would be feasible to randomise how often they should occur. This could be determined by rolling a die for each section, biasing the outcome according to taste; e.g.,

[34] It should be noted that the riff units themselves contain musematic repetition, a feature of the random riff generator.

rolling a 1 might equal "hanging bit", or alternatively, this chance might be increased to rolling a 1 or a 2, and so on.

In a time where the sun descends alone	"Fading Like A Flower" – Roxette
Don't be afraid to feel this way	"Faith" – Celine Dion
I'm not cynical.	
I'm not cynical.	
Oh yes you are.	
Oh yes you are. X2	
Highway run into the midnight sun	"Faithfully" – Journey
And in your eyes I see ribbons of color	"Falling Into You" – Celine Dion
This is what it's like falling out of love	"Falling Out Of Love" – John Denver
When you walk by every night	"Fantasy" – Mariah Carey
There's a lucky man who'll take you far away	"Far Away" – Demis Roussos
Feelings, nothing more than feelings	"Feelings" – Morris Albert
Strollin' in the park, watching winter turn to spring	"Feel Like Making Love" – George Benson
Strollin' in the park, watching winter turn to spring	"Feel Like Making Love" – Roberta Flack
Chorus	
You give me fever	"Fever" – Joe Cocker
It's fine	"Fine" – Whitney Houston
Find a way to my heart, and I will always be with you	"Find A Way To My Heart" – Phil Collins
The first time ever I saw your face	"First Time Ever I Saw Your Face" – Roberta Flack
Fly me to the moon	"Fly Me To The Moon" – Frank Sinatra
So won't you fly with me	"Fly With Me" – 98 Degrees
Ev'rybody's looking for that something	"Flying Without Wings" –Westlife
Baby, I know the story	"Fool Again" – Westlife
Call me crazy, call me anything you want	"Fools Like Me" - Trisha Year Would
Chorus	
Those days of love are gone	"Forever" – Mariah Carey
In your arms I can still feel the way you want me when you hold me	"Forever And Always" – Shania Twain
Friends, we started out as friends	"Forever By Your Side" – Manhattans
Love, look at the two of us	"For All We Know" - Carpenters
For Once in my Life	"For Once In My Life" - Justin Gaurini
For Once in my Life	"For Once In My Life" – Stevie Wonder
Are those your eyes?	"For The First Time" – Kenny Loggins

Figure 5-12: Table showing quasiorder lyrics

The quasiorder lyrics (see *figure 5-12*) for each verse were generated in the following manner. A search on the Internet for love song lyrics brought up the site *romantic-lyrics.com*, the menu of which made it possible to search for love songs by title. Songs were organised alphabetically in the ranges A to E, F to J, K to O, P to T, and U to Z. A letter was chosen at random (F) and the first lines of songs filed under this letter were listed. Because the order of these lines was dictated by the alphabetical position of the song titles (as shown above),[35] this is a quasirandom process, however, the song may not be perceived as random, since each line makes grammatical sense and displays thematic consistency, i.e., it has romantic connotations throughout. A three-dimensional representation of this song to show the degrees of randomness and order, in process and perception, would be very similar to that shown on page 201.

5.4 SUMMARY AND CONCLUSIONS

This chapter has investigated quasiorder or randomness perceived as order, and how repetition and randomness can be used in popular music to achieve this in varying degrees by taking into account structural predictability. It has been demonstrated how the basic element of a repetition, the unit of repetition, can be generated randomly to create riffs, and how these may in turn be used to generate structure.

Repetition in popular music is complex and manifold, and without doubt, one of its most distinguishing features. Adorno argued it is essential in order for the most commercial popular music to be consumed as a leisure activity. In addition, popular music must "listen for the listener", a characteristic achieved through standardisation and pseudo-individualisation. Middleton argues that two kinds of repetition dominate in popular music, musematic and discursive. These are associated with the organisation and structure of compositions, the interplay between repetition at the level of the phrase and details within.

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[35] The lyrics of the chorus were not generated using this technique, but pre-empt the critical debate sparked by composing love songs in this manner.

It was argued that a third kind of repetition also exists in the form of sampled materials. Where once the timbre of a recording would be its unique and defining feature, it can now belong to several pieces of music, by different artists, decades apart. The use of samplers in popular music has brought about this change. With many artists sampling pre-existing music, repetition has taken off in a new direction. Cauty and Drummond incorporate sampled music into predictable structures, satirising popular music by reducing it to a formula. In so doing they reduce the amount of fresh listening the audience has to do. The effect is opposite to the kind of alienation avant-garde music is sometimes accused of through the use of non-standardisation and unfamiliar materials.

The Manual provides a formulaic approach to song writing, which may potentially be randomised whilst maintaining the pre-listened characteristics of popular music as expressed by Adorno. By way of a structural analysis of Cauty and Drummond's number one song "Doctorin' the Tardis", it was revealed that their system worked by turning Adorno's account of popular music (dictated by pseudo-individualisation and standardisation) into a recipe for success. They seem to agree with Adorno's conclusion that the details of a popular song bear no relation to its structure, and exploit this through nonsense songs.

For many artists, samplers provide a way of adding nostalgic qualities to their work, enabling them to connect directly to past "golden hits", as if to gild them with some sort of legitimacy. But for others (e.g., Oswald), the ability to use pre-existing recordings has offered new ways of commenting on structural predictability. Oswald treats sampled materials by removing all predictable musical syntaxes and formulaic uses of repetition, rearranging them into strange and alien patterns without destroying the origin timbre. Oswald's structural use of repetition in the track "Dab" is defined by the musematic repetitions of delay effects, where the number of repeats is unpredictable, but the timbre is easily identifiable. The overall effect is one where structure is defined by the musematic repetition, rather than the other way around.

The central issue of the next chapter is the idea that listeners approach pieces of music with preconceived ideas of what to expect. They make predictions about the direction each new listening experience might take, by referring to their personal backlog of accumulated musical memories. All kinds of things play a part in this process, which takes place within an instant and, for the most part, without listeners being consciously aware. The accuracy of these predictions increases with familiarity; the better acquainted the listeners are with the behavioural patterns of the thing they are trying to predict, the more likely they are to conclude, "I thought something like that might happen". In chart-orientated popular music, this is made especially easy for a number of reasons, most obviously the familiar structures used and the dependence on repetitive figures. Also discussed are issues surrounding how listeners receive and perceive randomness in music.

CHAPTER 6

RECEPTION AND PERCEPTION

The aim of this chapter is to examine the reception and perception of unpredictability within popular music. This is embarked upon with three main sections. Section 6.1 discusses social attitudes towards unpredictable popular music, the issues surrounding the musical group formed to support this research and audience reception. In section 6.2, the perception of randomness is investigated, offering both qualitative and quantitative theories. Section 6.3 explains the method and provides the analysis of the results of a survey conducted into the perception of randomness. This chapter ends with a summary, section 6.4.

The reception of music is strongly connected to the social conditions of the time. In popular music of the late 1960s, a shift towards experimentation and the pursuit of artistic freedom developed alongside an emerging and politicised counterculture. Within this social climate, unpredictable popular music was well received. It is much harder to find support for such music under today's conditions. Visual media of dissemination have had a dramatic impact on the face of the music industry.

Section 6.1.1 argues that the public's attitude towards experimental and progressive music has changed over the years in line with this increase in the importance of image. It provides an account of the central role television now plays in marketing pop groups as "brands", a point expanded on by Malcolm McLaren, who argues that this has resulted in a situation where new ideas are less important than record sales. This provides a social context for the issues raised in section 6.1.2, which discusses the experimental popular music group formed to back this research. By way of interviews with members of the group, an anecdotal account is set out covering how and why the group was formed, the views of those involved, audience responses to unpredictability and the influence of this feedback on the musicians. This theme continues in section 6.1.3 in which feedback obtained from within the popular music industry regarding experimental popular music and unpredictability is discussed.

Section 6.2 is concerned with qualitative and quantitative approaches to understanding the perception of randomness in music. Very little research has been conducted in this field, so it has been necessary to draw upon outside disciplines, such as psychology. Of particular relevance here are areas relating to pattern recognition. The section begins with an explanation of Gestalt theory and in 6.2.2 it is shown how this may be applied to music to give a generalised account of perception. In 6.2.3, Dynamic Attending provides a psychological explanation of how "pre-listening", as defined by Adorno, might actually work. In section 6.2.4, several empirical experiments conducted by psychologists into how people perceive and simulate random behaviour are presented. These include trials conducted by Falk and Konald into the visual perception of randomness and those conducted by Wagenaar, in which similarities are found between the perception of randomness and random behaviour.

Section 6.3 offers a methodology and interpretation of information gathered from a questionnaire used to determine how respondents judged the degree of audible randomness in three contrasting pieces of music. The conclusion takes into account the influence a musical education might have on the results, such as the ability to identify composition techniques aurally.

6.1 EXPERIMENTAL POPULAR MUSIC UNDER CURRENT SOCIAL CONDITIONS

> Debbie is thirteen years old. [...] When the *Secret Office Where They Run Everything From* found out about Debbie, they were thrilled. [...] She was immediately chosen to become the *Archetypical Imaginary Pop Music Consumer and Ultimate Arbiter of Musical Taste for the*

> *Entire Nation* – from that moment on, everything musical in this country [the USA] would have to be modified to conform to what they computed to be her needs and desires. (Frank Zappa, 1989)[1]

Since this research began, it was intended that the creative element would be divided between works realised on computer and works performed by a group, in ways that would utilise the strengths of each (musicians can be instructed to act with spontaneity and of their own accord; computers are accurate and do not require constant rehearsing). In May 2001, a group was formed to facilitate praxis in this research. It quickly became clear that it was to face a number of obstacles. One of the problems was the lack of interest shared by many of the musicians who came to audition, not for the project so much, but in experimentalism in general. Some were suspicious about its avant-garde nature, questioning its authenticity; others were simply not interested in exploring further possibilities. It soon became apparent that this was a reflection of a more general attitude, as if a whole generation had been lulled into a sense of security and assurance by the wide range of products on offer to them that they could identify with.

Although no single factor can be held accountable for this, the mass media has undoubtedly played a significant role. Television has become very influential in how music is received, with the viewer subject to a content decided by programme planners whose interests do not usually lie with experimental popular music (be it predictable or unpredictable). In section 6.1.1, this point is argued further, before returning to the more immediate issues relating to my own group and its uphill struggle.

[1] Zappa, Frank with Occhiogrosso, Peter, *The Real Frank Zappa Book,* Picador, London, 1989, p. 192. This is taken from a speech Zappa made in front of the American Society of University Composers in 1984. The speech was titled "Is 'New Music' Relevant in an Industrial Society?" In order to make a living, Zappa argues, composers have to accommodate the tastes of the time. Where once court composers wrote for Kings and Queens, these days they write for the movie or TV producer, the head of the opera company, the lady on the "special committee" or her niece, Debbie.

6.1.1 The MTV Generation

Throughout the middle of the 20th century, the transition from radio to television meant that the public could finally see the people they had been listening to. Audience reception was no longer just about what the music sounded like as image began to play an important role too, especially in the popularisation of rock music. Launching a new product (e.g., a band) on television was a powerful way of drawing the public's attention; having an eye-catching image was more important than ever before. As a result, the music industry has become rather dependant on television.

Today, as in the 1960s, the popularity of a band is signified by its record sales. Launching an act is expensive and risky, to the extent that record companies are under pressure not to sign experimental groups. Part of the problem stems from the fact that the music industry has become increasingly embroiled in televisual entertainment, which forces constraints on musical freedom. Television requires a certain type of musical product. In *On Popular Music,* Adorno argued that popular music must be consumed in a specific way, as a leisure activity. Popular music television programmes provide mainstream entertainment, rather than forums for experimentalism and progressiveness, and since the music industry is now more dependent on the promotional capabilities of television than ever before, it is under pressure to conform. This point is echoed by McLaren:

> The music industry is not going anywhere, it has so much to sort out that the only way it can do that is through big take-overs from the TV and film sector.[2]

In Britain, the mid 1980s marked the introduction of cable and satellite television. Since then, MTV has played a role in the making and breaking of pop acts, but the single most important popular music programme in the UK, in terms of generating sales, remains the BBC's *Top of the Pops.* Unlike cable and satellite, the strength of using terrestrial television as a marketing tool is that a majority of people can receive it. *Top of the Pops* is

[2] http://www.muse.ie/archive/interviews/mclaren.html

itself a brand, with two spin-off programmes (*Top of the Pops Two* and *Top of the Pops Saturday*) as well as a magazine. *Top of the Pops Two* allows the BBC to repeat archived "classic" performances from the show, since it was first broadcast in 1964 – enforcing the process of naturalisation caused by the music industry's continuous self-referencing over the years, in which familiar musical devices become embedded into society's idea of what "good" music is. The magazine, on the other hand, is:

> Primarily aimed at teenage girls [and provides] all the pop knowledge growing teenagers could want. It aims to make the reader feel part of an exclusive club, to transport them behind the scenes so they get a real sense of what really goes on in the world of music. Exclusivity is the name of the game and the magazine goes to great lengths to ensure we feature the best artists and interviews.[3]

The magazine contains "kissable close-ups" of pop stars and is unsurprisingly free of any discussion about music, preferring "celebrity gossip".

When groups cannot appear on the *Top of the Pops*, promotional videos are shown instead. Music videos also provide groups with an opportunity to establish an image. They often deploy technical innovation in an attempt to grab the public's attention, but no matter how hi-tech or lo-brow they may be, their basic function is the same: to advertise the song. McLaren argues that in recent years, the dependence on visual imagery has led to bands becoming increasingly interpreted as brands. Like the wrappers on chocolate bars, the branding of pop groups serves to tell apart what are essentially very similar products:

> Marketing has taken over everything and ideas have been thrown out the window, there's no development, it's just sell! We're becoming suspicious – do we really believe in these brands? And inadvertently, the imminent recession is down to this, everyone is trying to sell what is basically the same thing; the same system and that thing was not very interesting to begin with.[4]

If ideas really have been "thrown out the window" the hope of attaining success through experimental popular music would seem to be doomed. But McLaren is offering a glimmer of hope. His argument looks beyond that of Adorno's. It predicts that "naturalisation"

[3] http://www.bbcmagazines.com/totp/

[4] http://www.muse.ie/archive/interviews/mclaren.html

might come to an end if consumers start to question the value of the brands that are targeted towards their tastes. He argues that this is starting to happen because, in spite of all that is available, there is little variation. To what extent this might be happening is harder to judge. When the process of manufacturing a pop act was displayed in front of the nation on the television programme *Pop Idol*, sales of singles increased. The programme's title was awarded to Will Young, who went on to sell 1.5 million copies of his debut single in the first week of its release.[5] In this example, television was crucial in marketing. Audience voting systems allowed viewers to become willing participants in the process. On this evidence, McLaren's prediction that consumers are becoming suspicious of marketing techniques is still some way off. Exposure to the manufacturing process, the treatment of artists and music as pure commodity, has not led to a mass uprising against the music industry but instead momentarily revitalised a waning singles chart.

Advertising and popular music have always been comfortable bedfellows; even the most avant-garde 1960-70s groups were not adverse to the occasional television commercial.[6] During the 1960s, major corporations adopted Freudian psychoanalytical techniques[7] in the development of new advertising strategies, designed to sell the idea of freedom to the emerging counterculture, in which popular music played a part. The idea that advertising could be used to change the world for the better was a belief shared by pop stars and politicians alike. As the Vietnam War prompted mass civil disobedience in the United States, John Lennon was aware of the role the media could play in spreading his anti-war message, "Give peace a chance".

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[5] Figure taken from NME online, 12th March 2002, http://www.nme.com/news/101069.htm

[6] For example, Captain Beefheart's dadaesque TV commercial for his album "Lick My Decals Off Baby".

[7] Based on Freudian motivation theory, these strategies saw "advertisers and marketers conceive of consumers as endowed with an intrinsic desire for self-realization. The qualitative methodology that it introduced also allowed the marketing profession to observe and absorb the new ways of life that were proposed by the counterculture [...]. Towards the early 1970s these elements blended into a distinctly 'emancipated' advertising discourse [...]". http://mcu.sagepub.com/cgi/content/abstract/5/3/251

> [...] The model for all the Lennons' peace propaganda was Madison Avenue advertising. John believed deeply in the power of images and slogans to affect the mass mind. He was sure that during his years as a Beatle he had mastered the techniques of manipulating the media [...][8]

Likewise, Zappa believed that the advertising techniques used to sell washing machines could be used to "change the whole country around painlessly".[9] Today, commercials and pop videos are almost indistinguishable[10] and the shock factor, which punk so brilliantly exploited (reversing value systems so that rubbish became product), has now become mainstream.

Not only is experimental and progressive popular music affected by these social conditions; all music created outside the dominant musical culture, with no means of creating a large-scale visual impact, will remain in relative obscurity. Of course, musicians are free to play whatever music they like, with or without an audience, so it may come down to a personal choice based on how deeply one craves popularity.[11]

6.1.2 Evil Dick and the Banned Members

This section is based on the author's experience of forming an experimental popular music group (Evil Dick and the Banned Members – see also www.polemicmusic.com), and because of this it is written in the first person. At times, reference is made to an interview conducted in March 2003 with the members of the group (see page 290).

I have used the pseudonym Evil Dick since the release of my debut CD, *Coprophagism* (1998); the name "Banned Members", an obvious pun on "band members", stems from my initial concern that once the group was up and running it would be barred

[8] Goldman, Albert, *The Lives of John Lennon*, William Morrow and Co., New York, 1988. http://www.biblion.com/litweb/biogs/lennon_john.html
[9] Frank Zappa interviewed by Frank Kofsky in 1967. http://home.online.no/~corneliu/Kofsky.htm
[10] Michael Jackson and Britney Spears have both made Pepsi commercials, which testify to this.
[11] On a personal note, having performed to small audiences of about twenty people and larger audiences of about 200, there have been occasions when the former has been more enjoyable because of its intimacy, the latter more enjoyable because of the atmosphere.

from every venue in town for failing to provide audiences with the type of musical entertainment they have learnt to expect from pub bands. But despite the group's uses of randomness, improvisation, lack of vocals or any discernable "band image", by our second year we had played most of the key venues in Leicester. In December 2002 we were invited to play at the Royal College of Art and received radio play on London's Resonance FM. Audiences have been appreciative, although our peculiar qualities have not gone unnoticed; following a performance at a Leicester venue called The Charlotte, a reviewer for the Leicester Mercury claimed:

> Their first couple of, well, not songs exactly, more pieces, sounded like they were making it up as they went along. However, as their set progressed you realised there was complex, cerebral experimentation going on [...].[12]

Leicester's local popular music scene is representative of many up and down the country and, although it has well over one hundred rock and pop bands,[13] there is little of the diversity or cross-cultural musical activity one might hope for in such a multi-cultural city.[14] One of the biggest challenges I faced when forming the group was finding musicians interested in new ways of making popular music beyond the current notions of what popular music should sound like.

On one hand, classical musicians are often notoriously bad at interpreting rock music because their training removes all the rough edges from their playing. They are too accurate, too formal. On the other hand, rock musicians are often musically illiterate and choose to play by ear, causing problems if the music is written down. It should be noted that these distinctions do not stop either type of musician from having a go at what the other does; hence Paul McCartney has written a symphony and the Royal Philharmonic Orchestra have played hits by the Beatles. However, suitable (and/or available) musicians prepared to experiment were thin on the ground in Leicester in 2001.

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[12] Leicester Mercury, 16 July 2003. The remarkable thing about this particular piece of rock journalism was that the person credited as its writer was not actually present at the gig.
[13] In June 2003 the website http://www.leicestermusicscene.co.uk featured 160 on its "Artists" page.
[14] The size of Leicester's Asian population is steadily overtaking that of the Caucasian population.

To promote the research, and make a plea for the involvement of local musicians, I sought the assistance of the local news media. There was little response from a "News in Brief" column in the Leicester Mercury,[15] no response to an interview on BBC Radio Leicester's "Breakfast Show" (see page 299) and nothing from postings in music shops and on the Internet. The group was eventually formed by word of mouth. It comprised a fairly typical rock band line-up: synthesiser, guitar, bass guitar and drum kit. The door was (and still is) left open for any other musicians to join.

During the early stages of forming the group, the main problem was getting musicians to commit to a project that bore little relationship to anything they had done before. This may have come about because society has failed to support experimental and progressive popular music to the same degree it has pop music. McLaren addresses the idea that bands today are performing Karaoke, defined as:

> Miming the words of others. It is a life by proxy, liberated by hindsight, unencumbered by the messy process of creativity. And not having to take responsibility from the moment its performance ends. I feel we live today in a karaoke world.[16]

Although punk rock was in resurgence at the time EDBM was being formed, the attitude and emphasis on "newness" which accompanied it the first time around were sadly missing in 2001. New punk was so assimilated into the marketplace that the idea of being opposed to "corporate rock" was little more than a distant memory.[17] With alternative clothing stores

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[15] Leicester Mercury, 21 May 2001, News in Brief: 'Aspiring musicians are wanted for a new Leicester-based band. But they won't be the next Hear' Say – this band will be making experimental music. The brains behind this venture is De Montfort University PhD student Richard Hemmings. He wants to bring something of the unexpected back into the music scene and is in need of fellow musicians to help. The 28-year-old said: "I'm looking for musicians who are interested in trying something different to what they have done before. An ability to read music might help, but it is not essential".'

[16] The Sunday Times (South Africa), "Chemical Karaoke", 9 June 2002. http://www.suntimes.co.za/2002/06/09/lifestyle/life11.asp

[17] According to McLaren, even the Sex Pistols are guilty of this. After their reunion in 1996, he commented: "The Pistols were mouthing the words of the group they were in, pretending they're still in but that group has long left the race. In their original form, they were a much more chaotic and angry offspring but it was a group that promoted an attitude that can be nothing other than a karaoke attitude today". http://www.muse.ie/archive/interviews/mclaren3.html

on high streets the length and breadth of the country, it was easily enough to look like a punk but none of the new generation seemed to want to embrace its values.

The band managed to stay together for over a year without a bassist, in spite of auditioning four[18] and being let down by many more. This period (which undoubtedly all groups go through to some extent) is worth focusing on because it underlines the lack of interest and general disregard for experimental popular music. Part of the problem could lie with the notion of "bandleader", a position I had to take on in order to set the group's agenda. Throughout the jazz era, it was common practice for a group of musicians to take directions from a bandleader, e.g., Duke Ellington and Thelonious Monk. Rock bands have tended towards more collaborative approaches, the success of which has often depended on the strengths and weakness of individual personalities and their compatibilities, e.g., John Lennon and Paul McCartney as opposed to George Harrison and Ringo Starr. Collaborations can work well, but can equally fall into disarray if individual musicians fail to take responsibility for their actions.

After considerable effort, I managed to find three open-minded musicians, with a desire to experiment. Both guitarist Guy Wilkinson (24) and bassist Peter Thorley (19) were avid fans of early 1970s jazz/progressive rock. Wilkinson cited the groups Nucleus (Ian Carr), Centipede (Keith Tippett) and Colosseum (Jon Hiseman), famed for their exploration of open form and free improvisation, as influences. But despite this interest, and having

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[18] Bassist A was classically trained and could sight-read perfectly. Whether ironically or not, his love of Beethoven was coupled with an appreciation of manufactured pop groups like S-Club 7. At his audition he revealed he did not know what was meant by avant-garde but coped with the music sufficiently well to be offered a place in the band, which he accepted. His failure to appear at his third rehearsal prompted a swift e-mail exchange which revealed he had other commitments. He had joined an orchestra. Bassist B was a fan of the Velvet Underground and seemed genuinely interested in joining an experimental group. An audition proved difficult to arrange but when eventually he was able to attend one, he dealt with the music adequately and accepted the offer to join. The follow week he failed to appear and in a follow up e-mail declared that college work was taking up too much time and that he could not commit. Bassist C was into heavy metal and thought we were too weird to ever get a gig. He turned down the offer to join but expressed an appreciation for what we were trying to do. Bassist D was suspicious that we were trying too hard to be avant-garde. He accepted the offer of joining the band but failed to appear the following week. His parting words were to contact him prior to our first gig so he could come along and heckle. Eventually, we started gigging as a three-piece, with our first performance on 31 May 2002.

previously led two bands, Wilkinson had never played free improvisation until he joined EDBM.

Peter Gregory (47) was a professional drummer during the 1980s, with a respected underground Leicester rock band called Deep Freeze Mice. The band released a number of LP's; were played on Radio One by John Peel; toured parts of Europe and also gave Gregory his first experience of free improvisation.[19] In spite of this previous experience (or perhaps because of it) Gregory still found the idea of free improvisation a challenge, albeit an interesting one, and was cautious of audience reception.

> I think that what you can't do is expose people to too much indulgent experimentation when they're [the audience] on a night out, because there's only a certain amount of it that they'll be prepared to take. You have to pace everything...[20]

Initially, EDBM's repertoire implemented a range of different degrees of randomness: some sections were fully composed (although performances often varied unpredictably, e.g., by mistake or as the result of an experimental whim), there were sections that involved a degree of indeterminacy (such as the coloured dots pieces) and other sections founded on group free improvisation. Gregory was acutely aware of the power exerted by pub and club venues with a regular clientele, and of how groups are expected to provide entertainment rather than "enlightenment", at least, until a fan base has been established:

> [If] people were going out and buying tickets to come and see us at a venue – then we'd get more freedom to dictate what we can do. But when you're attending a regular venue where there are bands on seven nights a week, people will attend the venue because they know they can predict a certain standard of entertainment, a certain approach to entertainment. I think it's hard to pull them too far out of that without being unduly provocative.[21]

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[19] Gregory has spoken of the time Deep Freeze Mice' founding member, Alan Jenkins, had the group free improvise for half-an-hour in a blacked-out room, recalling the famous performance of a piece by George Brecht at the New School for Social Research around 1958, when the performers took on Cage's idea and played it in the dark so that they could not take visual cues from each other. Nyman, Michael, *Experimental Music: Cage and Beyond*, Studio Vista, London, 1974, p. 12.
[20] The Banned Members interviewed by the author, p. 294.
[21] Ibid., p. 295.

Dadaists and punks excelled at provocation, but Gregory's argument, viewed in this context, was that the audiences attending the Cabaret Voltaire during the 1910s and CBGB[22] in the 1970s went to those venues expecting to be provoked; it was never undue. Of course, once a fan base has been established, this in itself can exert a powerful influence over the musical direction of a group, disastrous in the case of progressive music with its drive for constant reinvention.

> [...] during the 1950s and '60s, an even more self-conscious avant-garde grew into a movement that saw honour only in permanent change. [...] the impetus now was to carry on changing as fundamentally as possible at all costs [...] and to see everything in terms, not so much of good or poor quality, but of progress or non-progress.[23]

During the late 1960s, the jazz composer Mike Westbrook, with this principle in mind, took to the idea of stirring things up. Many of his early compositional ideas were shared at the Old Place (formerly the premises of the Ronnie Scott Club). For eighteen months, this London venue was central to innovations in British jazz; audiences were appreciative and numerous. Outside London, on the contrary, the music caused a different reaction. Westbrook recalled one particular occasion:

> I remember we had one gig at Loughborough and I'd written out a few rock and roll riffs [...] there were bits of free improvisation in between, complete chaos, and the audience was very irate. [...] Musicians were leaving off the stage not wishing to be associated with what was going on. [...] I was very excited by that evening.[24]

Without the understanding, support and feedback of audiences at the Old Place, it is hard to imagine how Westbrook could interpret such a negative response with such optimism (the desire to challenge conventions aside). One must conclude that having the confidence to commit to an artistic vision out of step with what is popular at the time is gained through experience. Gregory identified this as a contributing factor to his personal outlook.

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[22] CBGB is the famous New York club which helped launch the careers of American punk bands like Television, The Ramones and Blondie.
[23] Carr, Ian, *Music Outside*, Latimer New Dimensions Ltd., 1973, pp. 130-131.
[24] Ibid., p. 26. No date is supplied for the gig in question, but in the paragraph that follows, Carr states that Westbrook "stirred things up" once again, at the Festival Hall in 1968.

> [...] from the moment we first gigged as a three piece and people liked it, that was a big hurdle for an unusual band to get over, and that gives you a whole lot of confidence. If you know one audience likes you, and you go out and you have a bad night, then you know it was either a bad performance or a bad audience.[25]

Gregory's cautious outlook contrasts with that of Thorley's, whose experience of bad audience reactions prior to joining the group had prepared him for the worst. Nonetheless, Thorley had greater confidence in the audience's ability to appreciate original music.

> It's the difference between original bands and cover bands. People clap for original material bands because it's something new. They haven't heard it before, so they can't judge it too harshly. But people are always more discerning with cover bands because they expect something from them. It's got to sound how they want it to.[26]

Gauging audience reaction is never easy, especially in environments where alcohol is on sale. The use of questionnaires in this situation is met with the audience's reluctance to participate; their natural reaction is to back away from anyone with a clipboard. Responses influenced by alcohol may contain bad data. Questionnaire forms end up as beer mats and paper aeroplanes. Pubs, unfortunately, are not conducive to controlled conditions. People often give more honest reactions when their guard is down, and when their leisure time is not being intruded upon. Useful feedback has been obtained from the recordings of EDBM playing live. Although it must be taken into consideration that audience members influence each other when showing their appreciation, it has been the case (on more than one occasion) that the free improvisation sections have received the most enthusiastic applause, this from audiences expecting to hear rock and indie music. It is also possible to catch parts of conversations and comments made by audience members on tape. After a performance of the piece "Coloured Dots IV" at a gig in November 2002, two audience members were heard to comment, "very good", "very different". During the RCA performance of "Coloured Dots III" (also known as "Sweaty Retard", *Rock 'n' Random,* track 14) someone is heard commenting, "Ah, fantastic!" as the piece draws to its thrilling conclusion. Such encouraging feedback would be missed were it not for the eavesdropping capability of live recording.

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[25] The Banned Members interviewed by the author
[26] Ibid.

How the audiences perceive the music is much harder to judge. At some gigs, the coloured dots process was described (often amidst heckles of "get on with it"). This educative approach, although rare in popular music, has been adopted by a number of composers and improvisors whose musical pursuits have been ahead of their audiences' understanding.[27] Before he was told about the coloured dots process, Thorley's initial impression of Coloured Dots III was that it was fully composed. He feels, that in terms of *sounding* random, the coloured dots pieces do so more than the free improvisations. He offers an intriguing theory:

> When it comes to free improvisation, anything can happen, but it's not [about] melody; a lot of it is sound. I think the coloured dots pieces could possibly sound more random [...] because most people are more attuned to melody and tune than they are to sound.[28]

Although music based on organised sounds, rather than chords and melodies, has become increasingly acceptable in popular music, e.g., the album *Kid A* by Radiohead, it is not representative of the norm. Pitch still plays a crucial role, with new songs and songwriters in constant demand by the record industry. Most people have very established ideas about what music should and should not sound like. Regarding the coloured dots pieces, Gregory makes a similar comparison to that of Thorley:

> I think that there are parts of the coloured dots pieces that are much more aggressively in your face – from the audience's point of view – than the free improvisation that we do.[29]

More recently, the group has increased the amount of improvisation it uses throughout the set. Methods of conducting improvisation with hand signals have been used to allow spontaneous manipulation of the music. Free improvisations are combined with the use of samples, some of which are looped in stereo in such a way as to gradually go out of synchronisation, resulting in a continuously changing sound (although repetitions would occur if the samples were played long enough).

[27] Throughout the 1960s, a number of jazz musicians e.g. Graham Collier and Michael Garrick, took to explaining their music to concertgoers. In popular music, Zappa was one of the few to adopt educative measures (e.g., on "Black Page II", *Zappa in New York*, 1977).
[28] The Banned Members interviewed by the author.
[29] Ibid.

To summarise the main points of 6.1.1 and 6.1.2, audience reception is very much determined by social trends, which are greatly influenced by the media. To play music outside these trends is to risk exclusion. The benefit, however, is the freedom to explore new and uncharted musical territories. Experimental popular music is destined to remain an unpopular area of popular music but this is the price one has to pay for daring to look into the future and imagining what might become popular.

6.1.3 Music Industry Feedback

A good reception is something record companies take extremely seriously because it provides an indication of commercial appeal. Whilst conducting this research, a few opportunities arose when it was possible to gain some feedback from people working within the popular music industry regarding the commercial potential of experimental procedures and randomness. In this section, two such occasions are described anecdotally, a) a demo jury (see page 300 for transcription) and b) a response from a music agency.

In May 2002, I decided to test one of my unpredictable pieces in front of a panel of industry experts at a demo jury held at working men's club in Leicester. On this particular occasion, the demo jury was organised by the Musician's Union. Present were three "industry experts" (including a Virgin A&R representative), each available to pass comment and offer advice on whatever music was brought along.

I chose to play a track called "Anchovies in the Ice Cream" (*Rock 'n' Random*, track 4; see page 257) which utilises a number of randomising procedures at the compositional stage. After playing the first ninety seconds of the track, it was stopped and the jury deliberated over what genre it might fit into ("green mouse, obsessive, speed-freak-state mentality"). Then, the Virgin representative asked what I had been trying to do and, rather unhelpfully, I replied with the question, "What did it sound like?"

"To be honest with you, it sounded like a ZX Spectrum computer music..."

Although it had been my intention to create a piece of music that used low sample-rate sounds, I had not considered others might view this as evidence of poor production skills.

"What's wrong with that?"

"Nothing's wrong with that"

One of the other panellists then added,

"It's not a song. It's not song writing. It's just a collection of sounds".

There were certainly some unusual sounds in the music, including a toy space gun, which was capable of producing a number of different explosion and siren noises. But to say it was "just a collection of sounds" implied that no sense of organisation had been perceived, when in fact the music was structurally very standardised. The jury members did not comment on the use of feedback or the randomness of the guitar break, maybe because other aspects of the piece distracted them. At the end of the evening, several members of the audience congratulated me on the track saying it was their favourite of the evening. In spite of the panel's put-downs and general lack of appreciation for a track which challenged their expectations, some people liked it.

The music industry is fixated on finding potential hit songs. On a separate occasion, I sent a demo CD to the Caragan Music Agency, based in Suffolk. The response I received confirmed my previous exchange at the demo jury. Having sent to them a range of songs and instrumentals (including one containing cryptographic randomness), their reply focused on the tracks which they perceived as having "the strongest tunes", i.e., the songs:

> The structure of each track is notable as things that you want to happen, generally do happen where you want them to, i.e., the songs build well and develop nicely from start to finish, good placement of parts and length of individual segments. [...] The song writing technique is good.[30]

If proof were ever needed that unpredictability is undesirable in popular music, it is surely to be found within these sentences. According to Caragan at least, making things happen when the listener is expecting them to happen is a mark of "good song writing technique".

[30] Letter to the author, May 2004.

Randomness is simply too unpredictable for listeners of pop who need guidance every inch of the way. It would seem that Adorno's cynicism, and Cauty and Drummond's mischievousness are as applicable to chart-orientated music today as they always have been. Standardisation still plays an essential role in the perception of popular music. In spite of the efforts of popular music's experimentalists to diversify, there appears to be little change in the working mechanisms of a classic pop song.

The next section is concerned with the perception of randomness in music. It discusses a number of theories and experiments from outside disciplines.

6.2 THE PERCEPTION OF RANDOMNESS

Music perception, or the analysis of musical experience, comprises a number of diverse disciplines, including psychology, linguistics, neurology, neurophysiology, artificial intelligence, computer technology, acoustics, and music theory.[31] Above all, it is concerned with the experience of listening, in particular, pattern recognition, to which Gestalt theory contributed some important first steps.

6.2.1 Gestalt

While based at the German University in Prague, the German philosopher and psychologist Christian von Ehrenfels brought the cognition of art under investigation in his paper, *On Gestalt Qualities* (1890). He began by proposing that the German word "Gestalt", which means shape, figure or form, should be generalised in a particular way. He believed a Gestalt quality "is not a combination of elements but something new in relation to these,

[31] This list of disciplines was extracted from *Music Perception Online*. http://www.ucpress.edu/journals/mp/

which exists together with their combination, but is distinguishable from it".[32] Gestalt theory provides a method for qualitative analysis. Rather than attempting to understand a "whole" (i.e., the totality of the thing being perceived) by the study of its separate elements in isolation – reductionism – Gestalt seeks to explain the influence of a whole on the structures within: the interaction of all parts that comprise the whole.

> There are wholes, the behaviour of which is not determined by that of their individual elements, but where the part-processes are themselves determined by the intrinsic nature of the whole.[33]

This subjects it to the same criticism faced by all totalising theories, that by focusing on the holistic, they lack rigorous scientific analysis. At its inception, Gestalt theory was used to explain optical illusions, such as the Kanizsa triangle. The illusionary triangle is formed by the brain's innate ability to compensate for what is (or what it considers to be) missing. Unless all the component elements of the picture are viewed as part of the whole, our perception changes: remove the circular black shapes and the triangle vanishes.

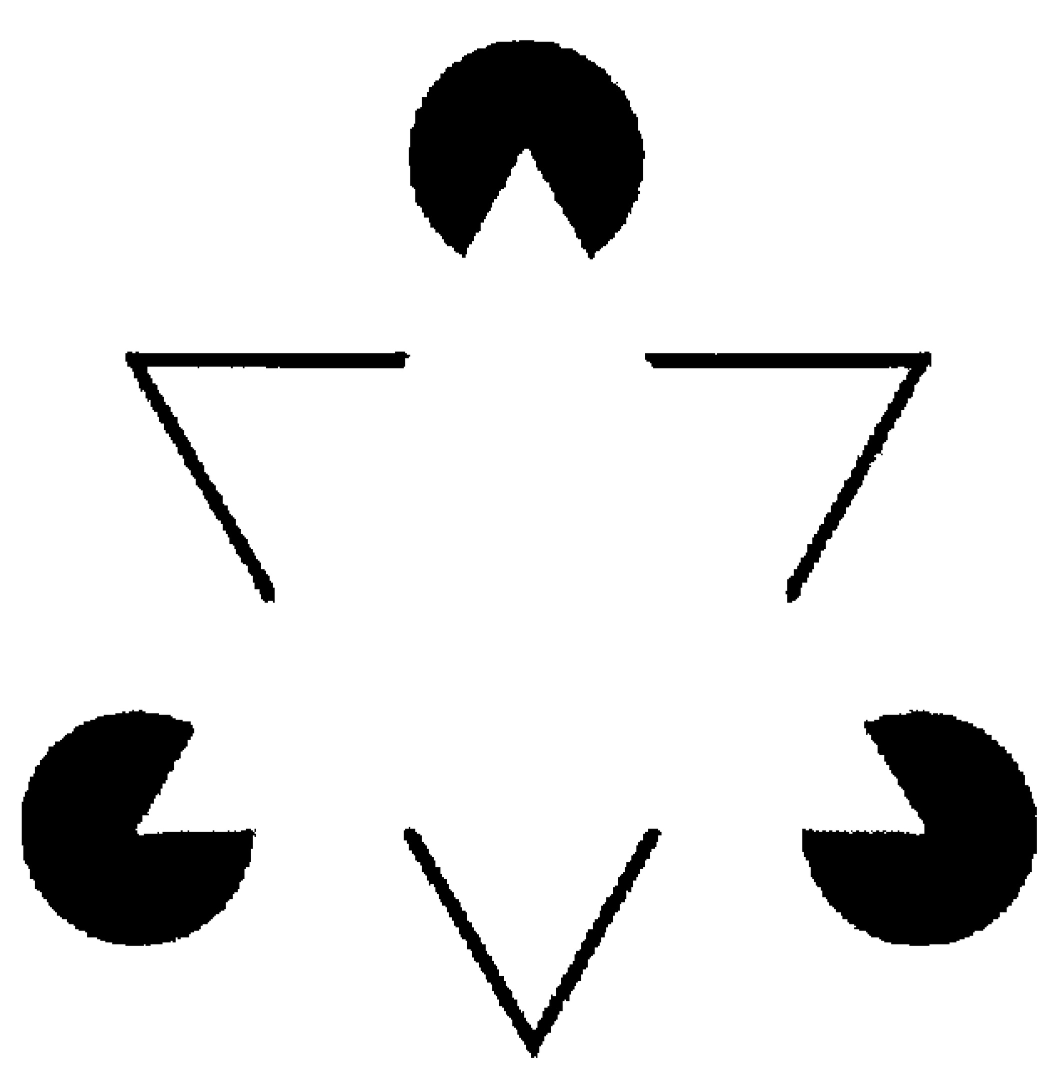

Figure 6-1: Kanizsa Triangle

Effects like this also take place in music. For example, when two sounds are heard a distance apart, the silence between them takes on a finite duration; without the two sounds marking the limits, the silence would (in theory) be of infinite duration.

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[32] http://www.vislab.usyd.edu.au/gallery/music/alyons/gestalt.htm
[33] Wertheimer, Max, "Gestalt Theory", Erlangen, 1925. http://www.enabling.org/ia/gestalt/gerhards/wert1.html

Stranger still is the way the illusionary triangle seems to be especially bright, an effect caused by the contrasting use of black and white.

The psychological use of Gestalt originated towards the end of the nineteenth century in Germany. Its leading figures, Max Wertheimer, Wolfgang Köhler and Kurt Koffka, opposed the "atomisation" of the analysis of experience into separate categories, e.g., associationism, behaviorism, and psychoanalysis. They sought to unite these various disciplines and form a broader general theory of perception.[34] Those who continue to research and practice Gestalt today regard it as a theory "to be understood not as a static scientific position, but as a paradigm that is continuing to develop."[35]

6.2.2 The Application of Gestalt Principles to Music

Although the first Gestalt psychologists were primarily investigating the perception of visual shapes, their theories also seemed to apply to melodies – auditory shapes. In a paper given before the Kant Society of Berlin in 1924, Wertheimer directly addressed the perception of music. He proposed that each note within a melody was "determined by the character of the whole." In other words, notes are experienced in terms of their relationship to the whole piece, not as part of a sequence of notes travelling from point A to point B, or a pitch moving in time.[36]

> [Gestalt theory] suggested that certain laws seemed to underlie our perception of form [...] These laws governed our tendencies to group elements in a visual field so as to constitute shape or form at a larger scale than the individual elements of the pattern.[37]

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[34] The Society for Gestalt Theory and its Applications, "What is Gestalt Theory?". http://www.enabling.org/ia/gestalt/gerhards/gtax1.html#kap2
[35] Ibid.
[36] Cross, Ian, "AI and music perception", AISB Quarterly, 1999. http://www-ext.mus.cam.ac.uk/~ic108/AISB99/
[37] Ibid.

Despite its non-scientific nature, Gestalt theory has continued to offer useful insight. Jay Dowling and Dane Harwood have identified a number of Gestalt principles which can be applied to the way melodic patterns are perceived. They are equally applicable to music that focuses on the organisation of sound, such as electroacoustic and free improvisation:

> **Proximity** = spatial closeness between elements within a pattern. (The closer they are the more we perceive them to belong to the same group or pattern.)
> **Similarity** = physical similarity between items in a pattern (The more alike they are, the more we tend to perceive them as belonging to the same pattern.)
> **Good continuation** = similar to proximity in that it depends upon our perception of the closeness of pattern items, but different in that it denotes our abilities to predict the future spatial "direction" or "trajectory" of a linear pattern based upon our most recent knowledge of the pattern's direction.
> **Common fate** = perception that a pattern consists of one or more layers or parts due to behaviour held in common by some of the parts.
> **Meanings within patterns** = the arousal of long-term memory memories, semantic memories or associations with language.[38]

These principles may also help explain why order sometimes seems to appear in randomness. Similar to the brain believing the Kanizsa triangle actually exists, the interpretation of random notes as composed music is akin to falling for an illusion. With this in mind, Gestalt theory seems an ideal analytical tool. It also shares the principle of holistic experience with Cage's opposition towards "focus" – another idea pertaining to auditory perception, adapted from visual perception. Cage wished for listeners to perceive music from every position, "physically and perceptually", not to focus on a fixed perception.[39] The connection to visual perception is made clear in the following account in which Michael Nyman explains Cage's concept:

> Focus is the engineer in charge of Cage's recording of his *Indeterminacy* stories in 1958 trying "to get some kind of balance rather than just letting the loud sounds (made by David Tudor) occasionally drown my voice out. I explained that a comparable visual experience is that of seeing someone across the street, and then not being able to see him because a truck passes between you".[40]

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[38] Dowling, Jay W. and Harwood, Dane L. Chapter 6: "Melodic Organization", *Music Cognition*, San Diego: Academic Press, Inc., 1986, p. 154.
[39] Nyman, Michael, *Experimental Music: Cage and Beyond*, Studio Vista, London, 1974, p. 22.
[40] Ibid., p. 21.

In more recent years, Gestalt theory has found renewed popularity in the field of artificial intelligence and many scientists see its value, despite its qualitative approach. Research is still being carried out to empirically prove or disprove the claims of Gestalt.

6.2.3 Dynamic Attending and Pattern Prediction

Mari Riess Jones's theory of Dynamic Attending[41] is especially useful when considering the perception of whole pieces of music. It is comparable with the "good continuation" principle of Gestalt theory in that it refers to how listeners make predictions over time. Her theory states that when listeners experience a piece of music, they automatically try to deduce when the events of the piece will occur in time. At a basic level, the time interval between the first two events of a piece may be used to predict when the third event might take place. If the time interval between the second and third event is less than or greater than the time interval between the first and the second, then the prediction is wrong. If, however, both time intervals are the same, then it is proved correct. Either way, the subject is able to use this information to predict future events. New predictions are based upon the success of previous predictions, where "success" is measured by way of a comparison with what actually happens. The whole process takes place unconsciously and within an instant, and is used to estimate events throughout the piece. It also occurs on different temporal levels; if specific rhythm patterns are repeated, they are grouped together, allowing a higher-level temporal framework to develop. This idea relates to the "proximity" principle of Gestalt theory, the grouping together of elements based on their closeness.

This theory can be used to interpret Adorno's theory of "pre-listening", which then becomes not so much a case of popular music "listening for the listener", but of being predictable for the listener. When perceiving standardised forms, the need for the listener to conduct pattern prediction is somewhat reduced because the probable outcomes are, to an

[41] Jones, M. R. "Attending to musical events", *Cogitive bases of musical communication,* American Psychological Association, Washington D.C., 1992.

extent, already mapped out. In popular music, listeners have grown to expect that certain things will usually happen and this expectation feeds back into the process of making popular music, since it is in the interests of those making pop records to meet with the demands of consumers. Here lies a link between perception and reception. To employ randomness is to work against the listener's instinctive ability to find patterns. This undermines the pleasures associated with pattern recognition (especially repetition) on which the success of chart-orientated popular music is largely dependent. However, it should be remembered that unpredictability has been popular (i.e., in the 1960s), and that pleasure is derived from the experience of difference as well as sameness.

6.2.4 Empirical Approaches

Although few empirical studies have been conducted into the perception of randomness, the opposite is true for the perception of music in general; the only drawback is that these are mainly studies on pitch relationships and rhythm, topics which seem less important in the wake of organised sound.[42] How we perceive timbre has yet to receive much attention, since empirical approaches tend to gravitate towards musics where identifiable patterns are the prerequisite. Some research has been conducted into the identification of salience cues, events in music which have an enormous influence on musical perception. These cues satisfy the listener's desires and expectations, providing something to latch on to amongst the myriad of possibilities the course of a piece of music may take. Unlike the Gestalt approach, empirical methods usually involve subjects tested under laboratory conditions. This may take the form of a comparison between composer intention and listener reception, a good example being the series of experiments carried out by Naomi Gregory into "the

[42] Over a period spanning five years (from autumn 1994 to summer 1999) in the quarterly journal *Music Perception* (University of California), nearly 40% of the papers collated were concerned with the perception of pitch and/or pitch relationships, i.e., harmonic/intervallic perception. There was not a single paper on the perception of electroacoustic music or popular music, although, jazz improvisation (*not* free improvisation) and African drumming were covered. http://www.ucpress.edu/journals/mp/index.htm

perception of tone hierarchies in atonal and 12-note music".[43] In each experiment, subjects were played a short piece of Webern followed by a single tone and asked to rate how well the tone fitted with the piece on a scale of 1-7, the point being that tonal hierarchies should not exist in serial music, although they often do.

6.2.4.1 Testing the Perception of Randomness

Psychologists often use binary sequences to measure the perception of randomness. The actual degree of randomness is measured in terms of repetition (the probability of a 1 being followed by a 1, or a 0 being followed by a 0) and alternation (the probability of a 1 being followed by a 0, or a 0 being followed by a 1). For example, the sequence 00000001000 has a 0.80 probability of repetition (implying a 0.20 probability of alternation), whereas the sequence 10011001010 has a 0.30 probability of repetition (implying a 0.70 probability of alternation). These probabilities are considered uneven since they are biased towards either repetition or alternation. If the probability of a binary sequence is to be considered unbiased then repetition and alternation must share a 0.50 probability, i.e., the probability must be even or equiprobable. This can be compared to any sequence where each individual event has two equiprobable outcomes, e.g., 100 flips of a fair coin.[44] Each event within a sequence is considered an "independent" or "simple event",[45] that is to say, the probability of the first event has no bearing on the second event and the second event has no bearing on the third event and so on. "Compound events" occur when two or more probabilities occur such that one directly influences the result of the other.[46]

[43] Gregory, Naomi, "The perception of tone hierarchies in atonal and 12-note music", May 1997. http://www.mus.cam.ac.uk/~ic108/PandP/Gregory97/Gregory97.html

[44] On average, an unbiased coin has a 0.50 chance of landing on either heads or tails each time a fact that remains the same even after 100 throws. Although, a small margin of error should be taken into account since a coin can also land on its edge.

[45] Bennett, Deborah, *Randomness*, Harvard University Press, London, 1998, p. 49.

[46] A compound event can be explained by considering the chances of drawing two hearts consecutively from a regular pack of 52 playing cards. The chances of picking a heart on the first go are 13/52 (or 1/4), the chances of picking one on the second go are 12/51 (or 4/17); the probability of picking them consecutively is 1/4*4/17=4/68=1/17.

For example, in a series of trials conducted by Falk and Konald, participants were asked to assess, either by visual inspection or reproduction from memory, which of the following appeared the most random: i) 111111000110000000111 or ii) 110101010100011010101. The tests concluded that the perception of randomness corresponded to the degree of difficulty the participants experienced as they tried to memorise each sequence. Patterns with high levels of alternation were more difficult to memorise and perceived as more random. Example (i) contained a lower level of alternation than (ii) and was easier to memorise. As a consequence (ii) was perceived to be more random than (i).[47] Falk and Konald connected this to the ease at which each sequence could be "compressed".

The origins of this idea may be found in Information Theory and data compression, the process of reducing the size of a piece of information by removing "redundancy". This branch of mathematics was developed in 1948 by Claude Shannon and was originally intended for application in communication engineering. At its heart is a view held by the Russian mathematician Andrei Kolmogorov, among others, whose pursuit of algorithmic randomness concluded, "A binary string is random if its shortest description is the string itself", i.e., a random binary string has no redundancy. This idea can be applied to music, e.g., pop songs contain lots of redundancy. The same chorus may be heard three or four times, but it only needs to be heard once to convey its message; likewise, if the chorus in question is based around a riff, this too can be compressed, possibly down to its unit of repetition.

Falk and Konald's experiment may explain why chart-orientated pop songs are necessarily simple. The easier they are to reduce to a few notes, the more likely they are to be remembered and this is a very important factor when marketing a song in a competitive market.

[47] Beltrami, Edward, *What is Random? Chance and Order in Mathematics and Life*, Copernicus, New York, 1999, p. 62.

In 1970, William Wagenaar used binary sequences to measure how accurate respondents were at judging the degree of randomness.[48] He used a large number of slides, each containing seven random-looking sequences of black and white dots.[49] Each slide contained one sequence with a repetition probability of 0.20, one sequence with a repetition probability 0.30, one sequence with a repetition probability 0.40 and so on up to 0.80. The position of each sequence remained undisclosed to the respondents, who were asked to choose which of the seven was most random-looking, i.e., contained a 0.50 probability of repetition.

Wagenaar found that respondents considered sequences with a 0.40 repetition probability to be the most random-looking. In other words, they favoured sequences with a higher alternation rate between the black and white dots than would occur in a true unbiased random sequence. He found that respondents were particularly biased against long runs of the same outcome, and concluded that they were seeing patterns where there was randomness and randomness where there was a pattern.[50]

The fact that respondents expect more alternations between the outcomes of a random sequence than actually happens implies that their ability to generate random sequences should display similar characteristics. In 1960, Paul Baken asked a class of seventy students to produce a determinant sequence of heads (H) and tails (T) as would occur if an unbiased coin was flipped three hundred times. Ninety percent of the students wrote sequences with too many alterations, having an average repetition probability of 0.42. This result compares favourably with the findings of Wagenaar. In a later experiment, Wagenaar discovered that the effect became even more pronounced when respondents were asked to alternate randomly between more than two choices. His experiment, which involved pushing six buttons randomly, produced a greater degree of alternation than is

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[48] Plous, Scott, *The Psychology of Judgement and Decision Making*, McGraw-Hill, New York, 1993, pp. 158-159 citing Wagenaar, William, "Appreciation of conditional probabilities in binary sequences", *Acta Psychologica*, 33, pp. 233-242.

[49] Black and white dots, heads and tails, 0's and 1's – the effect is the same: a sequence which alternates between two possible outcomes.

[50] Plous, Scott, *The Psychology of Judgement and Decision Making*, McGraw-Hill, New York, 1993, p. 159.

actually required. A musical analogy to this experiment could happen to musicians that try to play "randomly". Waganaar's results imply that they might instead head (fractionally) towards a pattern of alternation.

6.3 SURVEY ON THE PERCEPTION OF RANDOMNESS IN MUSIC

The following section is based on information pertaining to and stemming from an experimental questionnaire into the auditory perception of randomness. To assist in the preparation of this questionnaire (see page 302), a number of trial surveys were conducted over the Internet. Although responses to these were often incomplete and conditions uncontrollable, they provided some useful feedback with regard to the clarity of the questions and the suitability of extracts.

Although the main objective of the questionnaire was to measure the perception of randomness, respondents were also asked to provide answers to a variety of questions from more general areas of music perception, as well as areas of music appreciation, in the hope that their responses might supplement the main results gathered (see page 303). Two of the extracts used in the survey are *CD 1*, track 15, and *Rock 'n' Random*, track 7. Unfortunately, the third track referred to could not be included on *CD 1*.

6.3.1 Measuring the Perceived Level of Randomness

There are, undoubtedly, various methods of calculating the perceived level of randomness of a piece of music. In this questionnaire, respondents were asked to rate three pieces of music by how random they sounded. So as to achieve a more encompassing result, respondents were encouraged to estimate the randomness of individual musical parameters

– in other words, to make judgements on how biased towards patterns or the absence of patterns each parameter might be. An average response could then be generated for each parameter, based on the respondents' answers, and the perceived level of randomness per extract could be calculated as the sum total of relative parameter averages.

Practitioners of Gestalt theory would reject this method, claiming that the process of making estimates, generating statistics and amassing results to supply a figure for the whole does not enhance our understanding of *how* music is experienced. Reductive analysis cannot explain why, in some cases, patterned things are considered to be random and vice versa. Also, since music is potentially divisible into any number of parameters, the question arises as to which ones to use when generating statistics, and which ones to leave out. Hence, the experimental nature of this research.

In the field of visual perception, Peter Ayton, Anne Hunt and George Wright have argued that there is a problem with experiments (in particular, those conducted by Wagenaar) which equate randomness with "random looking".

> Randomly generated sequences of sufficient lengths always contain sections that do not seem random; hence asking subjects to choose the sequence that *looks* most random may induce a bias against repetition.[51]

For example, in a sequence consisting of the following two sections; a) 11111101010 and b) 10011000110, it looks as though 'a' is more ordered than 'b'. This is because 'a' contains a continuous sequence of repetition (111111) followed by a continuous sequence of alternation (01010). In fact, both sequences share a 0.50 probability of repetition and so, by Wagenaar's standards (although not in information theory), are equally as random.[52]

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[51] Plous, Scott, *The Psychology of Judgement and Decision Making*, McGraw-Hill, New York, 1993, p. 159 (footnote referring to Ayton, P. et al, "Psychological conceptions of randomness", *Journal of Behavioural Decision Making*, 2, 1989, pp. 221-238).

[52] There are five out of a possible ten repetitions in both sequences. Interesting though, 'b' would fail a different test of randomness, the null hypothesis, which bases its measure of chance on there being a 0.5 probability of each outcome being a 0 or a 1. In 'b' there is a 0.72 bias towards 1. This falls outside of the statistical norm.

Such patterns can appear in random data, although they are less likely to be chosen as good samples of randomness.

> Other studies have found, however, that subjects underestimate the amount of repetition in random sequences even when they are merely asked to detect whether the sequences were randomly generated – with no mention of how the sequences look.[53]

It is much harder to obtain a measure of randomness for a piece of music than it is for a binary sequence; music contains many layers of information that are processed simultaneously by the brain. It was necessary to take into account that perception might be influenced by factors such as intelligence and education. The connection between people's intelligence and their ability to see patterns in randomness is well documented. *Raven's Progressive Matrices* is an IQ testing method based on pattern detection. In order to be "culturally fair", the test uses neither letters nor numbers and is presented in the form of a sequence of fairly abstract, symbolic figures.

> The subject is required to understand the nature of the relationships within each sequence and select one figure which completes each sequence. By so doing, the subject demonstrates the degree to which a systematic method of reasoning has been developed.[54]

As the tests get harder, the patterns become increasingly difficult to detect and the matrices take on the appearance of randomness. Similarly, with extracts of music, some respondents may be less able to see patterns than others because of differences in IQ and cultural upbringing.

The influence of a musical education on the perception of music has been proven countless times, but how it influences the perception of randomness is unknown. By splitting the sample into two groups, it was hoped it might be possible to detect if there was any advantage to be gained by a musical education. Group A consisted of respondents with music qualifications, Group B, those without. Both groups were required to rate the

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[53] Plous, Scott, *The Psychology of Judgement and Decision Making*, McGraw-Hill, New York, 1993, p. 159.
[54] Taken from the Testing Agency Online Catalogue. http://www.testagency.com/viewpage.asp?id=8

amount of surface-level randomness (as opposed to its use as a seed value or compositional/improvisational strategy).

6.3.2 Method

The sample population consisted of 30 respondents, two groups of 15 students, those with music qualifications[55] (A) and those without (B), were asked to comment on the qualities of three pieces of music. Each track was played for one minute:

1. The Vengaboys, "We're Going to Ibiza!"[56]
2. Evil Dick and the Banned Members, "Gastrointestinal Emergencies" (*Rock 'n' Random*, track 7).
3. Evil Dick and the Banned Members, "Improvisation" (*CD 1*, track 15).

The choice of extracts was based on the presence of audible levels of randomness.[57] Extract 1, a piece of commercial pop, had no discernable random features; Extract 2 employed pseudorandomness; Extract 3 utilised free improvisation and is considered quasirandom (random-sounding/non-random process). Question H applied to each of them and dealt with the assessment of how random they sounded. It was divided into nine parts relating to different parameters of music. Each part required an answer within the range 1 to 7: a response of 1 was given for "not random" and a response of 7 was given for "truly random". The degree of randomness (expressed as a percentage) was calculated as the sum of the "mean"[58] responses to each question.

[55] Qualifications counted were a Grade 5 or above and/or a music 'A' level or equivalent qualification.
[56] "We're Going to Ibiza!" was first released as "Barbados" by Typically Tropical in 1975, when it reached number two in the charts. The Vengaboys's version is the epitome of 1990's cynically manufactured pop; a karaoke cash-in on the popularity of Club 18-30 club/drug holidays to the Balearic Islands.
[57] There is little point in measuring the perception of randomness bedded deeply within a composition, such as that used to control musical parameters in some algorithmic music.
[58] The calculation of means depends on the number of respondents who give answers. An 'X' result (see results tables on page 303) indicates a failure to supply an answer and to compensate for this they are not included in the mean. Consequently, the mean is contained within the range 1 to 7.

6.3.3 Results of Question H

Total number of parts per question=9

Answer range of each part=1 to 7

Therefore, the limits of the *response range* are:

Minimum score=1×9=9 (not random)

Maximum score=7×9=63 (truly random)

This implies a total response range of 63-9=54

An adjustment is required so that the range of answers fit between 0% and 100%. This is calculated by subtracting 9 from the answers (shifting the limits from 9 and 63, to 0 and 54) and by multiplying them by a factor of 100÷54=1.85.

Extract 1

Score total=10.3.
Expressed as a percentage:
⇒ 10.3−9=1.3
⇒ perceived degree of randomness 1.3×1.85=2.41%

Extract 2

Score total=39.6.
Expressed as a percentage:
⇒ 39.6−9=30.5
⇒ perceived degree of randomness 30.5×1.85=56.61%

Extract 3

Score total=46.
Expressed as a percentage:
⇒ 44.9−9=35.9
⇒ perceived degree of randomness 39×1.85=66.42%

6.3.4 Analysis of Results and Conclusions

The analysis of the results is conducted in two parts. Part 1 provides a general assessment, concerning the entire sample population, i.e., Groups A and B combined. Part 2 provides a comparative look at Groups A and B separately.

Part 1: General Assessment

Although no two respondents perceived the three extracts in exactly the same way, on average, they correctly placed them in order of how random they sounded. Group A and Group B were in agreement with regard to Extract 1, which was unanimously declared the least random, scoring an average rating of 2.41%. Over half of the respondents (56.7%) expressed an intense dislike towards this extract, finding it far too repetitious. Out of the 73.3% who thought it was "simple" music, 54.5% felt that this spoilt their enjoyment.[59] Extract 1 drives the melody into the listener repeatedly, leaving no room for unexpected events. The inclusion of such a predictable composition in a perception of randomness survey was to act as a benchmark, providing a set of comparative data.

Extract 2 caused a wide range of reactions, with respondents' ratings concentrated in the 3 to 6 range; the perceived degree of randomness was 56.61%. Of particular interest were the variations in "mode"[60] throughout the question responses, when Groups A and B are combined. Whereas all the responses to Extract 1 had a mode of 1, and all the responses to Extract 3 had a mode of 7, all the responses to Extract 2 had different modes, i.e., pitch=5, rhythm=4, duration=5, position of notes=3, etc. Each parameter was perceived as possessing a different degree of randomness, implying some were more ordered than

[59] Respondents also expressed dislike towards sounds used in the extract, but I would argue that in the hands of a good composer this would not be the case, as John Owsald has proven with Plunderphonics.
[60] The mode of a set of values is that value which occurs most frequently; in the results tables (see pages 303-305) the highest frequencies are highlighted in **bold** print and may be aligned with their corresponding mode score.

others. These findings coincide with the fact that degrees of repetition (52.9%) and of structure (66.7%) were also identified. Extract 2 was also considered the most enjoyable of the three extracts, scoring a mode value of 5 (34.5% of respondents).

Extract 3 produced interesting results. The sample populations both perceived it as the most random; the perceived degree of randomness was 66.42%. Members of Group A, however, seemed to perceive a higher level of randomness than those in Group B. This type of discrepancy may have been hinted at when Extracts 1 and 2 caused Group A to perceive a fractionally higher degree of randomness than Group B (Extract 1: Group A=1.2, Group B=1.1; Extract 2: Group A=4.5, Group B=4.4, on the 1 to 7 scale). The question is whether this has anything to do with the perception of randomness or the application of a knowledge concerning compositional/improvisational strategies.

Part 2: Comparative Assessment

The following section looks at the results of Question H in relation to Groups A and B, drawing conclusions when possible.

Pitch

In contrast to Extract 1, where Groups A and B both perceived non-random pitches, Extracts 2 and 3 caused a range of reactions. Group A identified a higher degree of randomness in pitch choices than Group B for both extracts, maybe suggesting that those with a musical education are less inclined to perceive melodic patterns within random pitches because they are more discerning towards what characterises successful melodic shapes. On average, Group A experienced the same degree of pitch randomness for Extracts 2 and 3 (5.4). This result may well reflect the perception of both random and non-random elements in both pieces; in Extract 2 this is certainly the case. Throughout the piece, a strict tempo is coloured with pseudorandom percussive sounds and pitches; the music is identifiably dance orientated, yet the details within are hard to predict, a characteristic not often associated with dance. Although Extract 3 was entirely improvised, placing more emphasis on sounds than specific pitches, respondents also perceived a degree of order, backing up the argument expressed earlier by Ayton, Hunt and Wright. In comparison, mode results for Group A for Extracts 2 and 3 suggest a wider difference of opinion. Extract 2 received a mode of 5, whereas Extract 3 received a mode of 7 (extremely random pitches).

Rhythm

Both groups considered the rhythm of Extract 1 non-random, with only a very minor discrepancy from Group A. Reactions to Extracts 2 and 3 provide more interesting results. Again, random and non-random elements are perceived. In the results for Extract 2, Group A averaged 4.1; in contrast, Group B averaged 3.3. This noticeable difference quite possibily reflects the focusing skills of each group. It could be that Group B focused more on the strict tempo of the rhythm section, whereas Group A found the erratic movement of the melodic section more significant. Without further investigation it is difficult to glean the truth. It is nonetheless interesting that in Extract 3, both groups experienced an increase in the degree of rhythmical randomness: Group A, 5.4, and Group B, 4.9.

Duration

On the whole, durations do not vary unpredictably throughout Extract 1. In Extract 2 durations are either very short, very long or both, but they are clearly ordered. In some respects, the results seem a little high, with Group A averaging 4.3 and Group B averaging 5.1. This possibly mirrors the degree of uncertainty experienced as the music progresses. That Group A has the lower estimate could be proof again that the musically educated are better at locating randomness in music than those without such training.

The Positioning of Notes in Time

Although there were no problems answering this question in relation to Extracts 1 and 3, it seemed to cause a wide range of reactions when applied to Extract 2. The question essentially refers to the degree to which the music is free from a regulated meter. Responding to Extract 2, Group A averaged 3.9 and Group B averaged 4.1. These results are quite close. In truth, this piece allows little freedom in positioning of notes in time; the sense of a pulse is strong throughout.

Transition Between Sections

Extracts 1 and 2 both contain different sections, but whereas Extract 1 moves along in predictable, four-bar phrases, Extract 2 changes direction abruptly and for no apparent reason; it does not follow a recognisable structure (e.g., ABABC) and is perceived to be more random. On the contrary, Extract 3 contains no sections and this was identified in Question F of the survey. When asked if the music in Extract 3 sounded structured or unstructured, 60% of the sample population believed it to be unstructured. It appears that respondents equated lack of structure to that of a highly random structure. Group A averaged 5.1 and Group B averaged 4.9. The results suggest that respondents found it possible to perceive free improvisation as random sequential events or sections.

Interplay Between Different Instruments

Judging the randomness of interplay between instruments was probably a little optimistic; however, Group A perceived more randomness than Group B in Extracts 2 and 3.

Tempo Variations

The tempos of Extracts 1 and 2 are both fixed throughout, yet whereas virtually all the sample population correctly identified this to be the case for Extract 1, the results varied considerably for Extract 2. This discrepancy could be based on a number of factors. It could be that since some parameters of Extract 2 sound random, respondents are more inclined to make false assumptions about other aspects of the piece. There may also be a confusion factor; that is to say, disorientating textures could trick the listener into perceiving something that does not actually exist. In Extract 3, there is no tempo *per se* since it is in free time. Nevertheless, both groups associated this lack of tempo with a random, variable tempo. Once again, Group A heard more randomness in Extracts 2 and 3 than Group B.

Dynamics

The dynamics of Extracts 1 and 2 were consistently flat throughout, an aspect noted by the respondents, who perceived them to be much less random than the other parameters tested in the trial. Group A perceived the dynamics of Extract 2 with an average of 3.1, whereas Group B responded with 4.2. The dynamics of Extract 3 were possibly the most unpredictable and this is reflected in the results produced by Group A. In comparison, Group B perceived the dynamics to be as random as those in Extract 2. This possibly stems from the lack of shocking dynamic contrast; there are no surprising moments of very quiet music followed by very loud.

Harmonic Progressions

In Extract 1, the harmonic progression is standardised. It exists as the type of chord progression common to popular music, and therefore provides few surprises to the listener. Nearly the whole sample population found this extract to contain no randomness in terms of harmonic movement. In Extract 3, Group A were confident that it was very random, with an average of 6.0, with Group B offering a more cautious 3.9. Whereas responses by Group A were focused at the high end of the scale, with a "median"[61] of 6, Group B's responses

[61] The median is calculated as the middle score when responses are arranged in ascending order.

covered a wide range, with a median result of 4. In free improvisation, harmonic progressions may be implied, but they can also occur by chance.

6.3.5 Improvements and Considerations for Future Trials

The results of this trial are interesting since they do suggest a link between musical education and a successful ability to identify randomness in music. The margin of error could be reduced with a larger sample group. Larger samples are better at absorbing responses to questions that are outside the statistical norm; equally, if a respondent's ability to make accurate judgements falters through lack of concentration, surveys with a larger sample are affected less.

One area that should be taken into account in future trials is the order that extracts are played in and how this affects respondents' perception. With a larger sample population divided into a number of groups it would be feasible to test different extract orders and trace common characteristics.

Another issue raised by this trial concerns the number of parameters the respondents were required to identify and judge the randomness of. Future trials may benefit from reducing the number to the most immediately recognisable parameters (e.g., those concerning pitch, rhythm, structural predictability), so that listeners may focus their listening more precisely.

6.4 SUMMARY

This chapter began by describing how attitudes towards experimentalism in popular music have changed since the progressive music of the 1960s. It was argued that as television began to play an increasingly important role in the dissemination of popular music, so too, did "band image". Under the current social conditions, this has resulted in a situation where mainstream music programmes with populist agendas, such as *Top of the Pops*, have become highly influential in marketing the products of the music industry to the public at large. The knock-on effect is that the popular music industry must also follow this mainstream agenda, posing a problem for more experimental musics.

Having presented these wider issues, the focus then shifted to an anecdotal account of the group formed alongside the research. Group members conveyed their personal opinions about playing random music in front of audiences. Feedback from music industry insiders revealed the difficulties faced by groups hoping to achieve the same levels of success as those achieved by progressive and experimental groups in the 1960s.

Gestalt theory was discussed in connection to the perception of music. Reiss-Jones's theory of Dynamic Attending was shown to offer a more detailed account of the process of listening, based on a series of comparative predictions and it was used to reinterpret Adorno's concept of "pre-listening". In addition, a number of empirical studies into the perception of randomness were also discussed, including one particular study by Falk and Konald which concluded that in the visual inspection binary sequences, the perception of randomness is associated with the difficulty experienced in trying to memorise the patterns of 0 and 1. Memorisation is compared to a process of compression; the easier a binary sequence is to compress, the easier it is to memorise. A number of other experiments were also discussed, such as those conducted by Wagenaar, into the connection between the perception of randomness and random behaviour.

The final section presented the results of a survey in which a group of thirty respondents were asked to assess the randomness of three pieces of music. The analysis of the results showed that they were able to establish the pieces in an appropriate order. It also offered potential improvements which could be made to the methods used on this occasion.

CHAPTER 7

SUMMARY AND CONCLUSIONS

The objectives of this chapter are to summarise the main points of the previous chapters, to offer some conclusions on the work presented in this thesis and indicate areas of interest for possible further study.

7.1 SUMMARY

This thesis has aimed to provide an investigation of new ways unpredictability can be used in popular music, through an understanding of the processes involved and how they may be perceived and received; it has explored potential methods of incorporating quasirandomness and quasiorder into popular music.

In Chapter 1, the notion that all music exists somewhere upon the predictable/unpredictable scale was introduced. Predictability was defined as the listener's ability to correctly judge future events based upon past events, by way of pattern detection. The work contained within the thesis was contextualised through a discussion about unpredictability in popular and avant-garde music. A graphical representation was used to depict the degrees of unpredictability in process and perception (see page 19). This was used to show the relationship between order and randomness. The expressions "quasirandom" and "quasiorder" were introduced in relation to perception, where something perceived as random may actually be a complex pattern resulting from some kind of ordering process; likewise, something perceived as order may really be randomness that just so happens to form a pattern. This idea was represented graphically (see page 21) showing clearly the relationship between order and randomness in process and perception. A three-dimensional method of representing the varying degrees of perceived order and randomness, with respect to the amount of randomness required by the system and the amount of control enforced by the system, was also offered (see page 22). This was used to plot the approximate position of the areas of research conducted in Chapters 4 and 5.

Chapter 2 began by tracing the historical roots of unpredictability in music. Musical parlour games sometimes involved dice to organise pre-composed musical elements, allowing players to create instant compositions without needing to know anything about composition. These techniques resulted in quasiorder. Chance, however, was not fully embraced by artists until the dada movement unleashed its potential. Tzara used chance (i.e., true randomness) in the generation of poems, whereas Arp preferred to construct randomness in collages (i.e., quasirandomness). A similar division emerged between Boulez and Cage in the 1950s. Boulez rejected Cage's use of chance in *Music of Changes,* but achieved similar results in *Structures 1a* by way of serial techniques. By comparison, Xenakis's highly formalised music is to some extent both quasirandom and quasiorder. His use of the law of large numbers generated an aggregate experience, formed out of many independently moving random lines. Identifiable shapes are formed out of randomness.

With regard to popular music, since the 1960s, some groups have incorporated indeterminacy into their work; for example, The Grateful Dead's "Dark Star" was never performed the same way twice. In the 1970s, both Bowie and Talking Heads used Oblique Strategies (Eno's pack of "self-help" cards to be chosen at random) to aid them with their creative processes. Punk bands often embraced mistake sounds in their polemic against progressive rock. In terms of unpredictability, however, few match the scope of different approaches applied by Zappa.

Chapter 3 investigated Zappa. Unpredictability was an important component of his live performances which incorporated indeterminacy (e.g., "Approximate") and free form segments (e.g., meltdowns), as well as fully-composed pieces. He sometimes incorporated mistakes made during rehearsals into alternative arrangements of songs, in what would become the "eyebrows" of the piece. He also developed a way of conducting improvisation (conduction) which allowed him to compose spontaneously with his group by way of a series of hand and body signals. He would often use tape to capture one-off incidents, sometimes releasing live versions of songs containing audience participation (e.g., "Be-Bop Tango [of the Old Jazzmen's Church]") or other such unpredictable outside element (e.g., tear gas grenades exploding during a concert in Italy). In the studio, his interest in unpredictability was equally multifarious. Using techniques associated with musique concrète, sections of the album *Lumpy Gravy* contain many unpredictable jump-cuts in rapid succession. Some techniques developed along the lines of basic quasirandom generators. Xenochronicity (meaning "strange time") involved the combining of unrelated recordings (usually performed at different tempi or in different time signatures) to create a quasirandom interplay between musicians in a way that never actually took place. Such process-based approaches to creating unpredictability suited Zappa's desire for control over his music. His movement towards the Synclavier in the 1980s gave him even more control, but it was not long before he began to miss the human element and started developing techniques to randomise things a little.

Zappa viewed each album as part of a greater whole, which he named Project/Object. On this basis it was argued that to play one of his albums is rather like choosing to play a section of an open work where there is no limit as to how many times the section is played. Another aspect of Zappa's art discussed was "conceptual continuity", the name he gave to the material that linked albums, movies, books, interviews and album sleeves. It was argued that "conceptual continuity" was an ordering process, but one that could be perceived as randomness on the surface of the material. A reference to something on one album might seem obscure, but in the context of Project/Object, it is not a singularity, but part of a thematic development that connects to elements outside the work. Unravelling "conceptual continuity" is a process of decrypting references, a type of pattern detection. It was from this aspect of Zappa's work that the connection with cryptography was made, since here was another subject associated with unpredictable patterns that mask hidden meanings.

Chapter 4 began by explaining cryptography. Different encryption algorithms were discussed, such as mono- and polyalphabetic ciphers, and ciphers based on sequences of binary code, such as stream ciphers and Markov ciphers. Processes like these are associated with PRN generation since they produce patterns intended to be unpredictable. An encryption process is vulnerable if it is in anyway predictable; the presence of a pattern in an encrypted message might provide a way to unlock its code, or its encryption key. This was the case with early ciphers upon the development of frequency analysis.

A connection between encryption algorithms and music was found to exist in compositions that incorporated secret messages, such as the serial compositions of Berg (in particular the *Lyric Suite*). With regard to polyalphabetic ciphers, the Vigenère cipher was revealed to operate in a similar way to *Structures 1a*. It was shown how Boulez's composition system produced quasirandom patterns and how both the Vigenère cipher and *Structures 1a* utilised a square grid approach to generate the material. To construct these grids, Vigenère rotated the alphabet, whereas Boulez rotated his series through transpositions. These findings were then used to investigate a number of experimental composition techniques synthesising cryptographic and serial techniques.

In Experiments I to III (section 4.3) it was shown how music could be generated by simple PRN generation based on binary grids. Each of the processes investigated in these experiments was initialised with a small random seed. Control over the parameters of pitch and rhythm is total. Although the details may be perceived as random, the structure was clearly defined, quite predictable and directly related to the construction of the binary grid. In the forth experiment, a Beatles melody was encrypted using the techniques discussed in the chapter. Pitch and duration were encrypted separately, with the results combined to produce a cipher-melody which was characteristically unrecognisable and unpredictable melody. This was then treated to further manipulation; a process of quasirandom generation based on transposition and rotation (again, techniques taken from serialism and cryptography) was used to create an abstract counterpoint.

Whereas Chapter 4 concerned quasirandomness, Chapter 5 aimed to develop a better understanding of quasiorder though an investigation of how repetition can be randomised. Middleton's analysis of repetition reveals two kinds common to popular music: musematic and discursive. This idea contributed to the creation of a random riff generator that would randomly choose a selection of pitches from a randomly generated note range, assign a random rhythm and repeat them a random number of times. In comparison to the approaches discussed in Chapter 4, the random riff generator controls fewer parameters since pitch, rhythm and structure are randomised. The upshot of this is that it requires a larger amount of randomness to function; each different riff requires a new set of random pitches and rhythms. Quasiorder is achieved because riff units (consisting of random pitches and rhythms) are repeated a random number of times, therefore a degree of order is perceived. Randomness may also be perceived, but the impact of this is dramatically reduced by way of repetition, so that singularities become multiplicities.

Adorno's theories on the pre-listened and formulaic nature of popular music, when used in conjunction with Cauty and Drummond's "Golden Rules", offer another approach to quasiorder, based on the structural predictability associated with chart-orientated pop music. The "Golden Rules" offer a rule-based composition system, where the raw material of a pop song can be anything, so long as certain structural conditions are met. These may also be randomised a certain degree, a point demonstrated by the construction of a quasiorder pop song.

Chapter 6 investigated the reception and perception of unpredictability in music. It approached the former by developing an understanding of the current problems faced by experimental popular music. This included a discussion on the affect MTV has had on the current music scene and McClaren's belief that in order for the music industry to market groups as brands, it must adopt an anti-experimentalist attitude. Within this context, the forming of Evil Dick and the Banned Members was discussed. This also involved reflection on the difficulties faced by the group when performing unpredictable popular music in bars and clubs. The chapter concluded with a survey into the perception of randomness in music, the results of which suggested a link between a level of musical education and ability to detect randomness.

7.2 CONCLUSION

Although it is hard to predict whether unpredictability in popular music will ever appeal to the mass market to extent that it did throughout the 1960s-70s, it is likely that it will continue to play a role, particularly within those groups on the fringes of popular music, whose position in the marketplace offers them more freedom to experiment than those working at the highly competitive, commercial end. With computers playing an ever-increasing role in the various stages of music composition and performance, as well as studio production, there are now more opportunities than ever before for musicians to get involved with the means of randomisation through, for example, effect plug-ins. Such readily available and relatively easy-to-use technologies are commonplace in professional recording studios and home studios alike. To what extent they are currently used by those creating popular music is difficult to determine, but their presence alone may be enough to trigger an interest in uses of randomness amongst those musicians who previously might not have considered it an option.

Of course, whether the music stemming from this prediction is perceived as random is another matter. Although being able to dance to a piece of popular music is not the be-all and end-all, having a regular beat would seem to be. Quasiorder approaches may be considered the better option in terms of audience accessibility; if the randomness is perceived as order, the music is more likely to fit in with majority of popular music. This might explain why, of all the techniques available to them, some rock musicians of the

1960s chose simply to be flexible with the form and content of their songs. The song "Five to One" by The Doors[1] may not immediately be perceived as unpredictable because of its dependence on the use of riffs, but it was structurally different each time it was performed. Such unpredictability may not be perceived until one compares several versions; only then do the structural differences begin to emerge.

Certainly, it is less common for popular groups to perform music containing noticeable levels of randomness, but as the research into reception showed, audiences can be fairly tolerant of random-sounding music. Quasirandomness has potential, particularly in regard to automated composition systems like those explored in Chapter 4. These pieces, based upon PRN generation (encryption algorithms and serial techniques), displayed a fascinating intricacy that would be unlikely to make an impression on the Top 40. However, like Zappa's highly critical approach to music, the quasirandom pieces in Chapter 4 comment on the limitations placed upon popular music. They take sounds derived from dance genres (typically drum and synthesiser sounds) and utilise them in unfamiliar and unpredictable settings. This embodies Zappa's belief that "Without deviation (from the norm), 'progress' is not possible".[2] The very idea that popular music should deviate from its well-trodden path is critical one because it provokes a collapse in the commodity cycle where progressive ideas break free and jeopardise the stability of the dominant system.

[1] The Doors, "Five to One", *Waiting for the Sun*, 1968.
[2] Zappa, Frank, with Occhiogrosso, Peter, *The Real Frank Zappa Book*, Piccado, London, 1989, p. 185.

APPENDIX A

ANALYSIS OF *ROCK 'N' RANDOM*

The purpose of this appendix is to discuss and analyse the EDBM CD, *Rock 'n' Random*, providing an understanding of the role randomness and order play in each piece. It discusses the techniques used, with reference to the main body of the thesis, and how they are to be perceived. For example, some sections of the CD that are intended to be perceived as random (e.g., track 9) are themselves constructed according to my own idea of what randomness sounds like, informed to some extent by the theories discussed in Chapter 6 regarding how people go about "behaving randomly".

It is divided into two sections. Section 8.1 offers a summary of each track in terms of the relationship between randomness and order. In examples where the randomness is constructed, choices made are addressed. In section 8.2, two of the tracks ("Gastrointestinal Emergencies" and "Hair Spider Stuck to Sock") are explained in further detail, in terms of the composition techniques and strategies employed. Extra attention is paid to "Gastrointestinal Emergencies", since it covers a wide range of different techniques relating to quasirandomness and order, especially relevant to Chapter 4. "Hair Spider" is chosen because it contains quasiorder and random techniques. At times throughout, reference is made to a perception survey conducted using a small sample group of seventeen respondents. Each was asked to indicate the predictability of a selection of pieces using a scale of 1 to 7 (1=unpredictable, 7=predictable), and the degree to which structure could be perceived (on the same scale, where 1=no, 7=yes).

Rock 'n' Random contains all four of the quadrants of randomness and order, in process and perception (see page 21); however, whereas the examples used throughout the thesis focus on quasirandomness and quasiorder procedures separately (Chapters 4 and 5 respectively), here the intention is to allow more freedom to explore compositional processes, at times merging the results of separately conducted experiments together. In *Rock 'n' Random,* order and randomness (true or perceived) often exist within individual pieces, sometimes occurring simultaneously in separate musical layers.

8.1 TRACK SUMMARIES

The following section gives a track-by-track breakdown of *Rock 'n' Random* in terms of the processes utilised and the intentions behind them. The chart below breaks this down into randomness, quasirandomness, order and quasiorder.

No.	Title	Random	Quasirandom	Ordered	Quasiordered
1	Biased to Zero	-	X	X	-
2	Coloured Dots II	-	-	-	X
3	Sensitive Dick	X	X	X	-
4	Anchovies in the Icecream	-	X	X	X
5	Is that Boston Again?	X	X	X	-
6	The Scissor Position	-	X	X	-
7	Gastrointestinal Emergenices	-	X	X	-
8	Whining Gimp	X	-	-	-
9	Montage	-	X	-	-
10	Hair Spider Stuck to Sock	X	X	X	X
11	Cherry Picking (Coloured Dots I)	-	-	-	X
12	Radio	-	-	X	-
13	No. K.	-	X	X	-
14	Sweaty Retard	-	-	-	X
15	Binary Sequence III	-	X	-	-
16	Fuckwits in the Biz	-	-	X	-
17	Our Instruments are Broken	X	-	-	-
18	Unwiderstehlich!	X	X	X	X
19	March of the PoMo Toss-pots	-	-	-	X

Figure 8-1: Types of randomness and order in Rock 'n' Random

An 'X' in a column indicates the type of process used. For example, track 1, "Biased to Zero" contains quasirandomness and order, since it uses the patterns produced by PRN (pseudorandom number) generation along with a melody composed by organising improvised elements.

1. Biased to Zero

This composition was composed in two stages. The first of these is discussed at length in Chapter 4 (see page 157). The title refers to the ratio of 0's and 1's in a binary seed used to initialise a simple process of PRN (pseudorandom number) generation. This is used in conjunction with random pitch maps (see page 142) to define the piano, bass and percussive elements of the music. When performing this, the quasirandom piano and bass lines were treated as an accompaniment. The synthesiser solo is not intended to sound random and is quite easy to distinguish from the quasirandom material, in terms of melodic and rhythmic content.

The track begins with a reconstructed extract from the BBC Radio Leicester Breakfast Show interview:

> Evil Dick: Umm...but some sort of other involvement.
> Jo Hollis: Any idea what you'll be called?
> Anchorman: (Laugh) That was Richard Hemmings there, speaking to our reporter...
> Evil Dick: Evil Dick & the Banned Members

These lines, clearly spoken in the wrong order (the editing does little to disguise this), set up the agenda for the whole CD, a combination of predictability and unpredictability. They exhibit quasirandomness since they are constructed to appear random through deliberate actions. Constructed randomness is characterised by irrational juxtapositions, leaps from one idea to another with no forewarning or reason other than to provide an unpredictable experience.

2. Coloured Dots II

This piece is discussed in Chapter 5 (see page 192). The recording was made at its premiere performance, before EDBM had a bass player. The bright sound of the "Biased to Zero", contrasts with the low quality of this recording. It is an example of a quasiorder process, where it is intended randomness (the pitch data) be perceived as order, due to the use of predetermined repetition and rhythmical parameters. What might be more surprising are the first few seconds of the piece, which contain a rapid succession of quasirandom (constructed) "noise bursts", bearing no relation to the previous piece or what is about to follow. In the survey this piece received a predictability score of 4.4, and a structural score of 5.3.

3. Sensitive Dick

This song is composed with the structural considerations of Cauty and Drummond, and Adorno in mind (see pages 180 and 176 respectively). It begins by setting up a familiar song structure that follows a predictable pattern consisting of two verses and a chorus. A verse contains two parts, each eight bars long. The first part of the chorus is seven bars long, but this is unlikely to be perceived as unpredictable. The time signature throughout is 4/4 and the chord progressions simplistic. The intention at this stage is to provide listeners with something they can predict, something that reliably confirms their judgements, in spite of the somewhat jangley and out-of-tune guitar.

The element of unpredictability comes from not fulfilling the expectations of listeners. After a chorus, a standardised pop song might go off in a number of directions (e.g., another verse, a repeat of the chorus, an instrumental link to another verse or chorus), all of which would be expected. In this instance, the chosen direction is a combination of free improvisation and constructed randomness (hence the X marks in the random and quasirandom columns in *figure 8-1*). Although listeners might be expecting something to happen at this point (1:57), it is unlikely such an extreme juxtaposition would be predicted.

Both this piece and "No. K." use an effect called a Mangle Filter. This is responsible for the strange sounding vocal, noticeable during lines such as " ...found out the other night (nigh...), I saw you leave your house by moonlight (aa)" (it should be noted that the lyrics also exhibit standardisation). The wobbliness of the singing, the pops in the audio and unpredictable repeats of parts of the vocal line come as a result of applying the Mangle Filter, more of which can be read about on page 306.

4. Anchovies in the Icecream

This track begins with a recording of the "demo jury" at which it was played in order to obtain some feedback from a panel of music industry representatives (see pages 223 and 300). Although the decision to include the extract was intentional, its content (the reaction of the jury panel upon hearing the track and the language used) was unpredictable.

Like the previous piece, this one is also based on a familiar form, i.e., ABABC; from a structural perspective, "Anchovies..." is not random. For the most part its sections are divided into groups of four bars, making it easy to predict when a change is about to happen. Its details, on the other hand, comprise a variety of riffs and solos, created by quasirandom and quasiorder procedures at the time of the recording.

During the opening bars of music, the instrument that sounds like a soprano saxophone (entering at 0:35, upon the completion of the first four bars) is actually a toy called a "voice-changer" feeding back. This part was constructed separately to the piece and then superimposed over the basic tracks (guitar, bass, drums); in a similar way to Zappa's quasirandom xenochronicity (see page 104).[1] This leads to a quasiordered/quasirandom guitar solo at 0:52 (see *figure 8-2*), where a number of techniques were used to create a "cartoon-style" guitar break. The objective was to create a series of melodic undulations from pitches belonging to a blues scale that would not tie in with anything else. A number of random choices were made according to a basic plan, e.g., to define the pitch of the first note, the range of the notes, the direction pitches travel in and at which point they should change direction. It should be pointed out that the notes labelled 'B' are almost a repetition of those labelled 'A', but at a different register; this intervallic difference was arbitrary. In this instance, 'A' is a unit of repetition, a singularity which forms the basis of a repetition. Repeating randomness is one way of achieving a sense of order. In Chapter 5, randomly generated patterns of notes are repeated to create riffs. Here the technique is used to create a sequence. A similar thing happens at 'C' and 'D'. The unlabelled bars in figure 8-2 are based on similar arbitrary decisions, tending towards unpredictable uses of repetition, such as the alternating patterns between the two pitches in the penultimate bar. Because of the speed of the piece (170bpm) individual pitches pass in a blur, so that the melodic shape is more prominent than the details. It parodies a style of rock guitar solo to emerge in the 1980s, which placed increasing emphasis on virtuosity and speed of performance over emotional content.

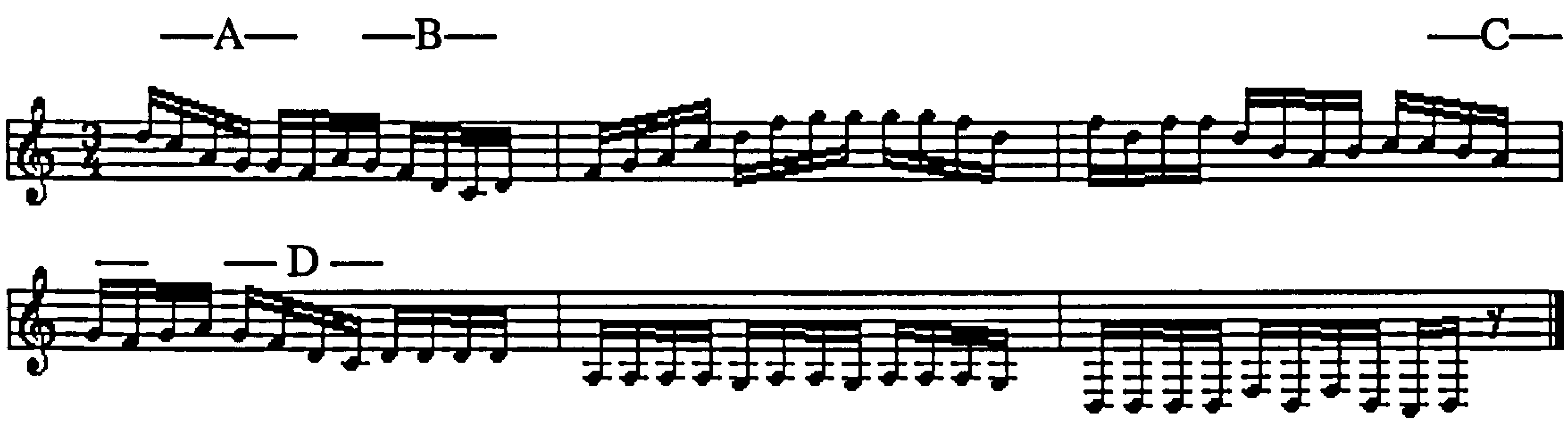



Figure 8-2: Part of quasirandom guitar solo in "Anchovies in the Icecream"

[1] To clarify the point, the relationship between the voice-changer "solo" and the other instruments is quasirandom. The solo itself is not intended to sound random, which accounts for the use of repetition.

Another section that might be described as quasiordered is the riff at 1:51. Based on the infinite-monkey theorem (see page 28), the riff's unit of repetition was selected from a supply of randomly generated material created by rapidly playing a mass of notes into a sequencer according to no plan. When this material was slowed down to hear the notes played at a less frenetic pace, this section stood out as sounding ordered in comparison to the rest. In cases like this, the composer's perception of what sounds musical is the deciding factor.

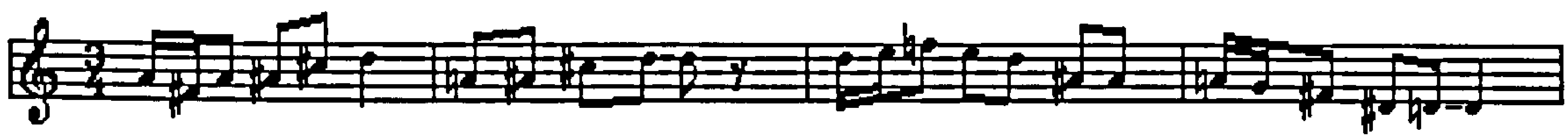


Figure 8-3: Quasiorder riff in "Anchovies in the Icecream"

The drumbeat used during this section is different to that used for the majority of the piece and is subjected to substantial signal distortion. At 3:17, during the latter stages of the piece, the voice changer feedback returns with repetition employed to give it some melodic shape, e.g., one particular sound is heard at 3:27, 3:29 and 3:38. Other sounds produced by the voice changer consist of unpredictable squeaks and squeals. It is the intention that the overall affect be perceived as existing between order and randomness.

5. Is that Boston Again?

In contrast, "Is that Boston Again?" is entirely improvised. One instruction was given to the drummer (Gregory), who was required to "play as if broken". This was interpreted as "play outside the meter" and resulted in a very unpredictable pattern with no identifiable pulse. It also accounts for the short duration of the piece; Gregory was never very comfortable playing in free time. The title of the piece offers a cryptic clue to an in-band joke. During rehearsals the guitarist (Wilkinson) would check if his guitar was still in tune by playing the opening bars of a song by the U.S. group Boston. Since no instruction was given to perform it during the improvisation, its inclusion is random, although the tune itself is ordered. It occurs at 0:22, moments before another change in direction at 0:36 (just as Gregory begins to form a repetitive rhythm) when a digital signal is time-stretched to the point at which it becomes a square wave. The pattern formed by this process may be perceived as random, although strictly speaking, it is an example of a complex pattern being perceived as random, i.e., quasirandom.

6. The Scissor Position

This track is based on a degree of suggestion and also displays a cryptic element. It comprises three separate recordings heard simultaneously. The first of these requires an anecdotal explanation. The vital, missing piece of information, which makes this an example of cryptographic randomness, is that the girl is holding a microphone. She is told to "hold it and give it a squeeze", whilst listening through the headphones. The recording of scissors snipping the air was made on another occasion. Both were superimposed to create the illusion of a perverse sexual act, which never really took place. Near the beginning (0:04) the scissors form a rhythmical pattern with the music heard in background (the third of the superimposed recordings) and this can be compared to the way Zappa's xenochronicity works. It is essentially a quasirandom process, but like true randomness, the patterns produced by xenochronicity can be perceived as randomness or order depending on their complexity.

7. Gastrointestinal Emergencies

This was one of the first pieces to be created using the idea of binary grids to create quasirandomness. As demonstrated in several experimental composition procedures in Chapter 4, binary grids can be used as basic PRN generators, resulting in pieces where the details are not easy to predict. Although this example is not automated to the same degree as those pieces, it incorporates a number of techniques in their early stages of development and others which amount to one-off experiments. There is also an element of quasiorder to the piece. Structurally, although it is unfamiliar in terms of chart orientated popular music (e.g., it does not alternate between verse and chorus), much of it can be divided into four bar phrases, so that changes can be predicted to some extent. Overall, the piece can be divided into five parts, which each explore a different way of using the patterns found within a binary grid. Owing to this, "Gastrointestinal Emergencies" is discussed in considerable depth in section 8.2.

8. Whining Gimp

Another recording from EDBM's first gig; in this piece the drums and synthesizer improvise freely around an intentional guitar drone. The synthesizer is on a random-hold preset to create random pitches, the rate of which is controlled. Timbre is altered using frequency filters. During the first half of the piece, it is heard sporadically as quick bursts of random beeps, then at 1:10 it is heard as a series of long notes. By the time the drums enter at 1:18, it begins to gather pace. The piece ends with delay signal (a concentrated repetition of the last synthesiser beep) feeding back, intended to form a balance with the randomness of the piece. It also provides a suitable segue to the piece which follows.

9. Montage

This is a short piece of constructed randomness (a type of quasirandomness) made up from audio waste material (little bits of audio trimmed from soundfiles while editing) and anything else close to hand, e.g., the guitar notes were taken from the track "Anchovies in the Icecream". The piece is not organised around a tempo, but has a sense of rhythm in terms of the repetition of sounds. Two types of repetition can be said to exist in this piece, consecutive and non-consecutive. For example of non-consecutive, a sampled guitar note with a pitch of G# is placed at arbitrary positions nine times within the first fourteen seconds. These tend to be separated by strange vocalisations, percussive noises and sounds played in reverse. Other sounds are repeated consecutively, for example, the three bass drum beats in the closing seconds. In terms of "Montage" being perceived as random, the results of the survey scored its predictability to be 1.7. This is interesting because in the same survey *Music of Changes* scored a predictability value of 2.5. One cannot conclude too much from this, accept that timbre may be a factor. "Montage" is organised in a manner not dissimilar to a list of different sounds to be heard in quick succession. Repetitions are used to enhance unpredictability by simply being too short to become established. The intention is to disorientate the listener. Conversely, *Music of Changes* has only the sounds of the piano and although it contains truly random events, these may at times edge towards quasiorder.

10. Hair Spider Stuck to Sock

This piece, which is discussed in some detail in section 8.2, consists of several sections realised using a variety of techniques. The first half of the piece is structurally very standardised and uses the same strategy as "Sensitive Dick" to set up a musical joke based on confirming the listener's expectations to a point, just so they may be dramatically dashed. It is the musical equivalent of "leading the listener down the path"; the music follows a familiar pattern, which to stray from results in unpredictability. Towards the end of the piece there is a section of musique concrète. This is intended to sound random and is constructed, keeping in mind Wagenaar's finding that people tend to underestimate the amount of repetition in randomness (see page 233). To utilise this psychological affect, this section offers little repetition. There is no logical connection between a honking bicycle horn, a twanging ruler, a mooing cow, a bunch of keys, a squeaky swivel chair, a pestle and mortar and a burp.

11. Cherry Picking

This piece, also known as "Coloured Dots I", is discussed in Chapter 5 (see page 192). It was the first piece composed using coloured dots, and is associated with quasiorder very much like "Coloured Dots II". This recording was made during a band rehearsal a month after forming the band on a rare occasion when we had a bass player. Although it is not a perfect performance, it clearly demonstrates how structural familiarity carries the listener, in spite of the inherent randomness.

12. Radio

During May 2002, BBC Radio One launched a website called *OneMusic* aimed towards unsigned bands. It offered bands a chance to have their demo tracks put online and reviewed by a selection of music industry experts. I sent them several tracks, including "Anchovies in the Icecream", "Hair Spider Stuck to Sock", "No. K" and "Unwiderstehlich!". Predictably, one of the less interesting tracks was selected for review, an instrumental built around a sampled dance beat (although not a dance track as such) not featured on *Rock 'n' Random.* In a section edited out of "Radio", it was described as "musically advanced", but this was considered to work against the appeal of the track: "If you've been trained as a musician, one of the things that perhaps people forget to do when they do records is maybe not to worry so much about the music and just create a good vibe".

13. No. K

As mentioned in the comments on the third track, this track makes further use of the Mangle Filter. The affects of this are noticeable at 0:40 when the drum track is squashed and stretched beyond recognition. The rhythms created by this process punctuate the music with unpredictable big band-style "stabs", which are difficult to predict because they stray across the beat (120bpm).

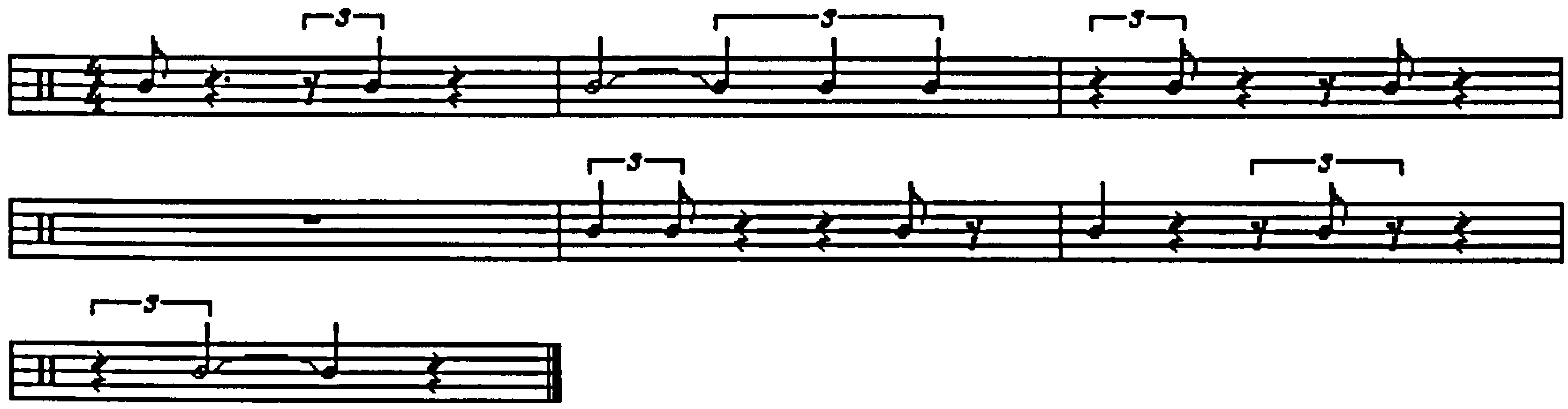


Figure 8-4: Rhythm created by Mangle Filter at 0:40

These stabs are interrupted at 0:46 by a flurry of guitar notes performed at a rapid speed. It is intended that this fast series of notes is perceived as random, although they are actually are based around a composed series of seconds and the fourths. This is shown below. The first interval is a diminished fifth or augmented fourth. This is followed by a minor second, which in turn is followed by a perfect fourth. These intervals are prominent throughout.

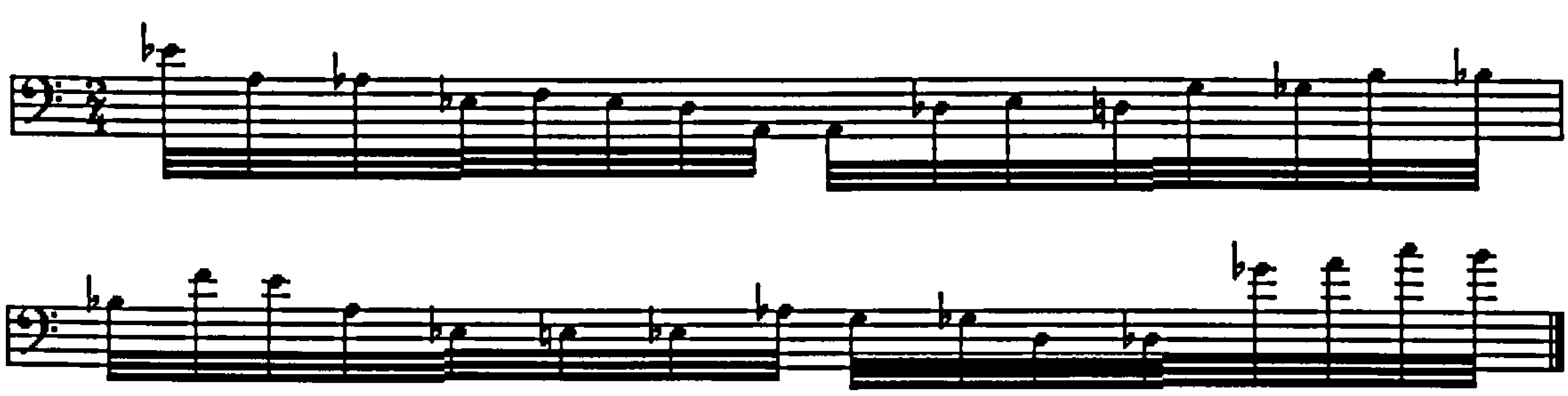


Figure 8-5: Rapid guitar notes heard at 0:46

The solo that occurs at 1:02 is accompanied by what could be described as a quasirandom rhythm section. The bass, guitar and a number of separate drum tracks, each a different number of bars long, are looped; the overall affect is that the music is constantly changing, whilst at the same time it is possible to identify elements of each loop.

14. Sweaty Retard

One way of winning over potentially hostile pub and club audiences is by making them laugh; announcing the title of this track usually gets such reaction. It was the third coloured dots piece. In this early version, from the same performance as "Coloured Dots II" and "Whining Gimp", it is performed fairly accurately. Like the other coloured dots pieces, it is quasiordered. The random choices of the musicians are within a structure of repetition intended to make them sound ordered.

15. Binary Sequence III

This is discussed in detail in Chapter 4 (page 143). Similar to "Biased to Zero", it is an example of a composition process based around PRN generation. The results of the survey suggest, however, that a sense of order is slightly more prominent; it scored 4.7 for predictability and 5.0 for the presence of structure. This latter score ties in with the order imposed by the binary grid (which is divided into sub-grids) and use of repetition in the bass line. Although randomness is detectable, easily identifiable patterns of structure and repetition may in this case have a bigger impact.

16. Fuckwits in the Biz

This track is a continuation of the criticism aimed at "Anchovies in the Icecream" at the demo jury, although it is edited to sound as if it refers to the previous track. With hindsight, it is easy to see that the confrontation was avoidable. "Anchovies..." is not a chart-orientated track and was always going to be a "miss" rather than a "hit" in the jury's eyes. A cleaned up "Sensitive Dick" would have been a much better submission. The question is this: would a demo jury showing appreciation be as interesting/entertaining to listen to? A comparison can be made to the no-hoper turning up for an audition on a reality television pop show and getting overtly upset when they are rejected; millions of people enjoy watching this kind of programme. It is along these lines that this track is included.

17. Our Instruments are Broken

This appears to be improvisation between guitar and synthesiser. In fact, for the first twenty seconds, it is a synthesizer solo performed alongside Wilkinson trying to find a suitable distortion setting. In conversation with Wilkinson afterwards he declared, "I wasn't really paying any attention to what you were doing. I was fiddling with my distortion pedal when I found this ugly chord, which I thought would be nice to throw in somewhere. Then, when I realised you were playing something pretty nasty too, I join in". Where exactly this happens is not obvious, but the string scratches at 0:48, which bear some similarity to the sounds being produced by the synthesiser, may be an indication.

18. Unwiderstehlich!

Like "Hair Spider" this piece covers a range of techniques. The opening riff was composed and accompanied by a drum pattern triggering RPMs.

19. March of the PoMo Tosspots

This is another example of quasiorder process (although a fair degree of randomness is still present, it scoring 2.5 for predictability). It is constructed out of fragments of a free improvisation recorded at a rehearsal. On this particular occasion, a trumpeter joined in with the band. With four musicians improvising independently, there was no obvious repetition in the improvisation. The fragments were therefore singularities. The selection process was entirely subjective, the aim being to create a tune out of something that was originally free. The alternation between two pitches is quite prominent at 0:05 (C#, D) and at 0:14 (D, G#), creating repetition not found in the source recording. In a similar manner, the same section of guitar/keyboard is used at both 0:03 and 0:24.

8.2 COMPOSITION ANALYSIS

The following section provides a detailed analysis of tracks 7 and 10 of the CD *Rock 'n' Random*, "Gastrointestinal Emergencies" and "Hair Spider Stuck to Sock". These pieces are treated separately because of the wide range of techniques they incorporate, which relate to the issues discussed in the main body of the thesis. Whereas "Gastro..." combines quasirandom processes with subjective structural organisation, "Hair Spider..." contains all four categories of randomness and order in process and perception (see page 21).

8.2.1 Method of Composition: "Gastrointestinal Emergencies"

"Gastrointestinal Emergencies" is based on the following series:

3	8	11	10	6	1	4	9	5	7	12	9
0011	1000	1011	1010	0110	0001	0100	1001	0101	0111	1100	0010

Figure 8-6: Series used in "Gastrointestinal Emergencies"

This series was converted into a grid in the usual manner. The piece begins with a vocal sample subjected to speed variation. This is followed by a number of sweeping chords

(0:08) made up from the original series. The first four notes made up the first chord, the second four notes made up the second chord, and the third four notes made up the third chord. The duration of each of these chords was dictated by a decision to keep the opening section sixteen bars long, hence, the first two chords last five bars, the third lasts six bars.

Bars	Pitches
1-5	3, 8, 11, 10
6-10	6, 1, 4, 9
11-15	5, 7, 12, 2

Figure 8-7: Opening chords

The quaver hi-hats (right speaker channel) take their pattern from the first few lines of the binary grid. This is an arbitrary decision since choosing any section of the binary grid would provide similar material); 0=open hi-hat, 1=closed hi-hat; each of these has a duration of a quaver, again, an arbitrary decision. By shifting the same binary material used for the hi-hat a semiquaver later, the cowbell pattern (left channel) was created.

4/4 00111000 | 10111010 | 01100001 | 01001001 | 01010111 | 11000010 | 00011100 | 01011101

00110000 | 10100100 | 10101011 | 11100001 | 10001110 | 00101110 | 10011000 | 0 1 0 1

Figure 8-8: Hi-hat pattern used in opening section

In the second section (0:42), the pitches of the lead synthesizer part were taken from an earlier etude based on the same binary grid, where the parameters of pitch, octave, duration and rhythm were all predetermined by the series. It uses the binary grid as a PRN generator. Counting down from the top of a column by the numerical value assigned to it (i.e., a note from the series) gives the first highlighted number in that column. This process is repeated, each time counting down by the value of the highlighted number until the end of the binary grid. The resulting pattern looks quite random. To generate the rhythm and duration, a total for the highlighted values for each column was calculated. Duration was based on the simple rule that when the column total was an odd number, rests would be added to the durations of the notes directly before them.

Column Number	Total of Highlighted Values in Each Column In Binary and Decimal		Notation (Applying the duration rule)
1	111010	58=even	♪♪♪𝄾 ♪𝄾
2	101011	43=odd	♩ ♩ ♪♪
3	101100	44	♪𝄾 ♪♪𝄾 𝄾
4	101001	41	♩ ♩. ♪
5	101110	46	♪𝄾 ♪♪♪𝄾
6	000001	1	𝄽 𝄽 𝄾♪
7	000010	2	𝄽 𝄽 ♪𝄾
8	000001	1	𝄽 𝄽 𝄾♪
9	001001	9	𝄽 ♩. ♪
10	100100	36	♪𝄾 𝄾 ♪𝄽
11	101001	41	♩ ♩. ♪
12	000001	1	𝄽 𝄽 𝄾♪

Figure 8-9:Table showing rhythms, durations and associated pitches

Pitches were then applied to these rhythms, with each of the durations assigned a note from one of the forms of the series, i.e., original, inversion, retrograde and retrograde inversion.

Octave information for each note was determined from a scale of 001 to 111 (the seven octaves of a standard piano), reading in groups of three digits from left to right across the binary grid and ignoring groups of three zeros. The follow diagram shows these relationships clearly.

	Pitches	Octave	Duration
ORIGINAL	B	1	♪
	E	6	♪
	G	1	♪𝄾
	F#	3	♪𝄾
	D	5	♩
	A	1	♩
	C	4	♪
	F	1	♪
	C#	2	♪𝄾
	D#	2	♪
	G#	2	♪𝄾𝄾
	A#	5	♩
INVERSION	G	3	♩.
	D	7	♪
	B	2	♪𝄾
	C	7	♪
	E	5	♪
	A	6	♪𝄾
	F#	4	𝄽𝄽𝄾♪
	C#	6	𝄽𝄽♪𝄾
	F	5	𝄽𝄽𝄾♪
	D#	1	𝄽♩.
	A#	1	♪
	G#	2	♪𝄾𝄾

	Pitches	Octave	Duration
RETROGRADE	A#	5	♪𝄾𝄾
	G#	7	♩
	D#	4	♩.
	C#	1	♪
	F	4	𝄽𝄽𝄾♪
	C	3	♪
	A	4	♪
	D	2	♪𝄾
	F#	7	♪𝄾
	G	2	♩
	E	3	♩
	B	2	♪
RETROGRADE INVERSION	G#	4	♪
	A#	4	♪𝄾
	D#	5	♪
	F	2	♪𝄾𝄾
	C#	7	♩
	F#	6	♩.
	A	2	♪
	E	1	♪𝄾
	C	6	♪
	B	1	♪
	D	3	♪𝄾
	G	5	𝄽𝄽𝄾♪

Figure 8-10: Application of Pitches to Durations
NB: Shaded area indicates the repeat of the rhythm pattern

To create a two-part harmony, the original and its inversion were superimposed onto the retrograde and retrograde inversion. This is shown in the extract below, where each note is labelled according to which version of the series its pitch is related to. The whole section is heard twice.

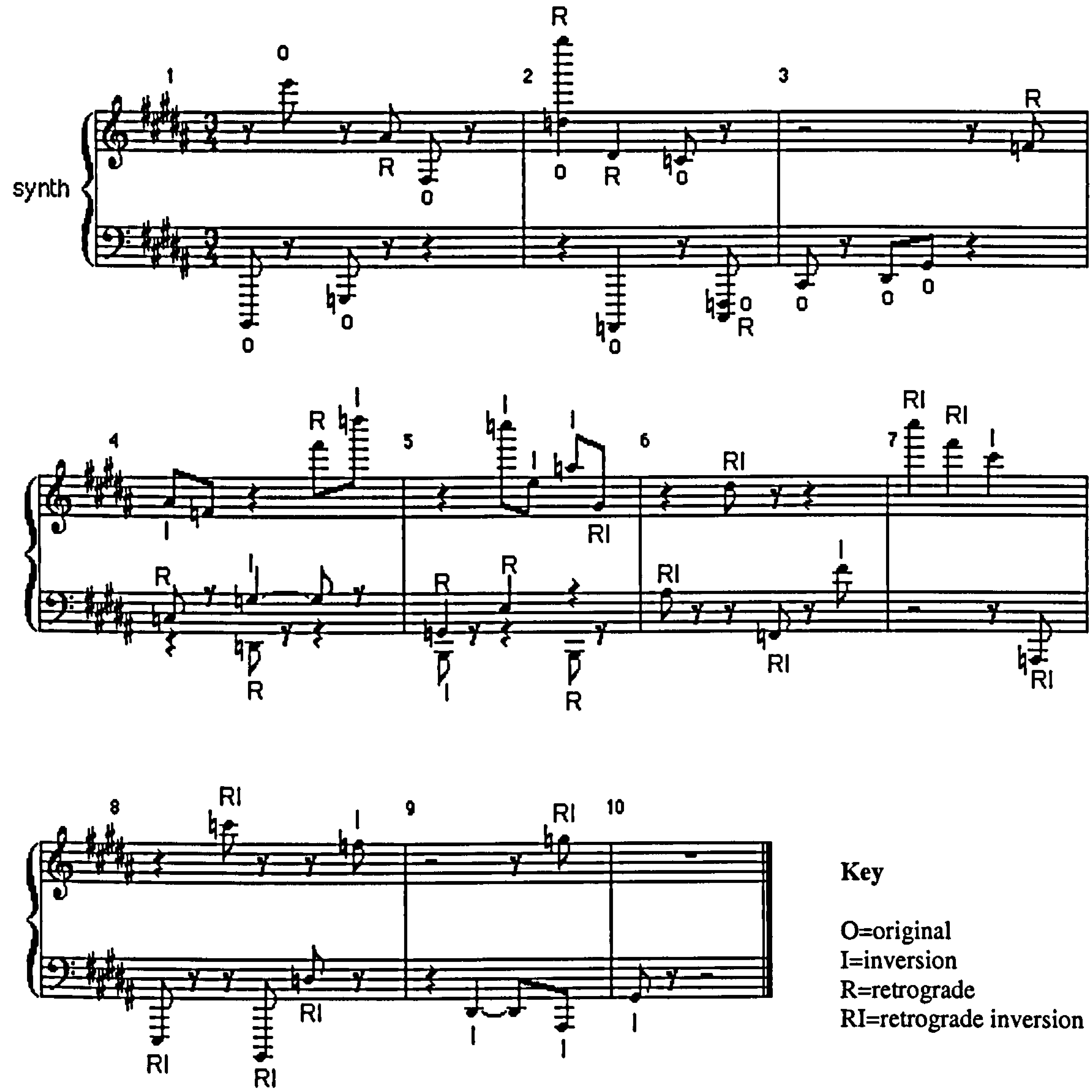



Figure 8-11: Score of synthesizer part used in the section

In terms of a work in/music out ratio, creating material this way is hardly efficient, but the results are unpredictable. Like true randomness, recognisable patterns also appear, such as an ascending bass line in bars 2 and 3, and the descending pattern in bar 7, but for the majority of the time, dramatic intervals result in an unidentifiable melodic structure. As a piece of serialism it is fairly uneventful, but as quasirandomness it fulfils its brief.

Turning the binary grid into landscape position and reading twelve rows from left to right created the drum pattern used during this section. These rows were divided into three rows of four; each four rows labelled cymbal, open hi-hat, closed hi-hat and snare. The grid (still in landscape position) was divided into three equal columns, representing three bars sub-divided by sixteen semiquavers. The three rows were then superimposed, creating a three bar, semiquaver drum pattern out of the highlighted PRNs, which was then looped, adding crotchet bass drums to root the rhythm in the dance tradition.

0:42

Cym		X					X		X				X			
O-hh					X	X		X	X							
C-hh	X				X					X					X	
Sn				X									X			

Bd	X				X				X				X			

Figure 8-12: Extract from drum pattern at *bar 1/section 2*

F		X					X		X				X			
D	X				X					X					X	

Figure 8-13: Extract from bass pattern at *bar 1/section 2*

The bass part for this section uses the cymbal and closed hi-hat pattern. It pitches (D and F) come from outside of the system, since they are the notes initially used to trigger the closed hi-hat and cymbal samples. At 1:00, the bass part transposes up a tone, a deliberate move to give the music a sense of moving forward rather than staying static. This transposition also affects the drum sounds, the effect being the inclusion of hand-claps and loss of the snare drum.

Following a rather unexpected pitch bend at 1:14, a vibraphone part is introduced. This uses the same pattern as the bass part only at a different pitch. The long synth notes are the original series. At 1:54, the pattern of notes used to trigger the hi-hat samples in section 1 (*figure 8-7*, where D=closed hi-hat, E=open hi-hat) are placed alongside the bass pattern (*figure 8-12*). A different part of the binary grid was used for the hi-hats.

In the third section (2:09) many of the patterns used are lifted directly from the first six lines of the binary grid, dividing them into four sections, A, B, C and D (see *figure 8-13*).

Segment A

0011 1000 1011 1010 0110 0001 0100 1001 0101 0111 1100 0010
0001 1100 0101 1101

Segment B

0011 0000 1010 0100 1010 1011 1110 0001
1000 1110 0010 1110 1001 1000 0101 0010

Segment C

0101 0101 1111 0000
0100 0111 0001 0111 0100 1100 0010 1001 0010 1010 1111 1000
0010 0011 1000 1011 1010 0110 0001 0100 1001 0101 0111 1100
0001 0001 1100 0101

Segment D

Figure 8-14: Segments of binary grid used in section 3

The hi-hat plays quavers for the first sixteen bars using segment C. The snare drum and bass drum also use segment C, but as semiquavers for eight bars (see *figure 8-15*), and because they finish playing it eight bars before the hi-hats, they play crotchets based on segment D for the remaining eight bars starting at 2:24, until 2:41 (see *figure 8-16).*

Open Hi-hat=0, Closed Hi-hat=1	Segment C, quavers, 2:09-2:41 (16 bars)
Snare=0, Bass drum=1	Segment C, semiquavers, 2:09-2:24 (8 bars) Segment D, crotchets, 2:24-2:41 (8 bars)

Figure 8-15: Drum pattern layout

(2:09)

Ohh	X				X				X				X			
Chh			X				X				X				X	
Sn	X		X		X		X						X	X	X	X
Bd		X		X		X		X	X	X	X	X				

Figure 8-16: Drum pattern using segment C, with hi-hat playing it as quavers, and snare and bass drum playing it as semiquavers.

(2:24)

Ohh											X		X		X	
Chh	X		X		X		X		X							
Sn									X							
Bd	X				X								X			

Figure 8-17: Drum pattern with hi-hat playing segment C it as quavers, and snare and bass drum playing segment D as crotchets.

In unison with the hi-hat pattern, from 2:09 to 2:41, are two alternating pitches. Similar to the previous section, these are the same pitches used to trigger the hi-hats. In the left speaker channel at 2:41, a guitar with lots of reverb improvises a similar alternation between the same two pitches. The sweeping chords are the same as those used in the first section. Later, (2:57) percussion is again derived from the binary sequence with 8 bars of semiquaver drums using segments A and B, set against hi-hat quavers using segment B.

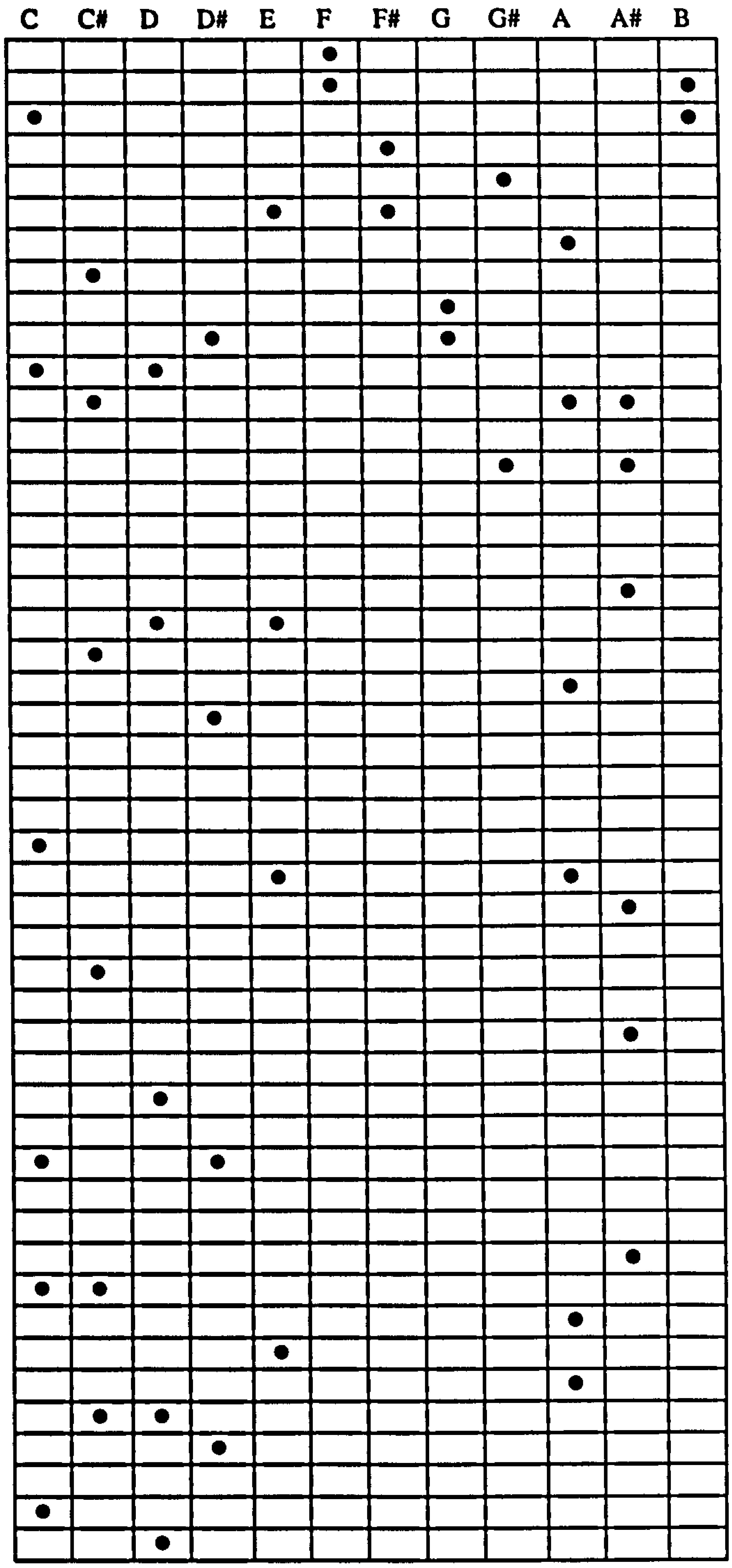


Figure 8-18: Player piano version of binary grid

Section 4 (3:15) uses a lot of the material from the previous sections. For example, the hi-hat semiquavers from 3:15 to 3:21 are taken from the first line of the binary grid used in

Section 1. The bass drum and snare from 3:21 to 4:03 use part of segment B from Section 3 (played twice as fast and looped six times). The pitches at 3:15 are the same as those used in the bass line of section 2.

The final section (4:03) uses the highlighted points on the binary grid as if they were holes in a player piano score (see *figure 8-18*). The original series is replaced by a chromatic scale, as would be the case were it to be performed by a player piano. In the right channel it is heard forwards and backwards, twice. At 4.31 it doubles its speed and plays it once again, forwards and backwards. The left channel contains the complete reverse of this. MIDI drum sounds are triggered by the pitches of the "player piano" pattern.

The fifth section also makes references to parts other sections. The original series is heard as long notes in the background. The bass line uses the same pattern as the closed hi-hat and cymbal in section 2. In the very last moments of the piece is a very short section, which is also based on this pattern.

8.2.2 Method of Composition: "Hair Spider Stuck to Sock"

The objective behind this piece was to combine the three categories of randomness referred to throughout this thesis (true randomness, quasirandomness and quasiorder) with actual order. Certain aspects of the piece are to an extent predictable. For instance, the structure obeys Cauty and Drummond's third Golden Rule (see page 180), but only to a point, i.e., introduction, verse 1 (0:12), verse 2 (0:31), chorus 1 (0:50), verse 3, verse 4, chorus 2, breakdown (2:16); but instead of following this with a double length chorus, the music takes a radical tangent into what becomes a surreal musical landscape.

The bass line of "Hair Spider" uses a combination of RPMs and composed notes. The RPMs are used throughout the verses. Four different pitches (C, D, G and Bb), all within an octave are randomly superimposed on a shuffle rhythm. This can clearly be seen in the transcriptions below, which compare the first three bars from verse 1 with those of verse 2.

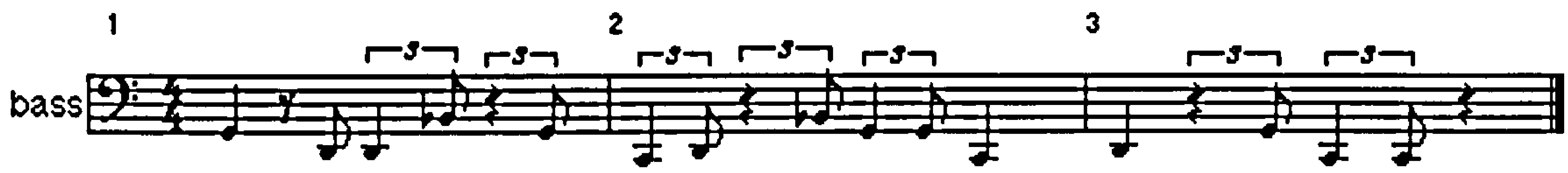


Figure 8-19: Extract from "Hair Spider", verse 1, bass line

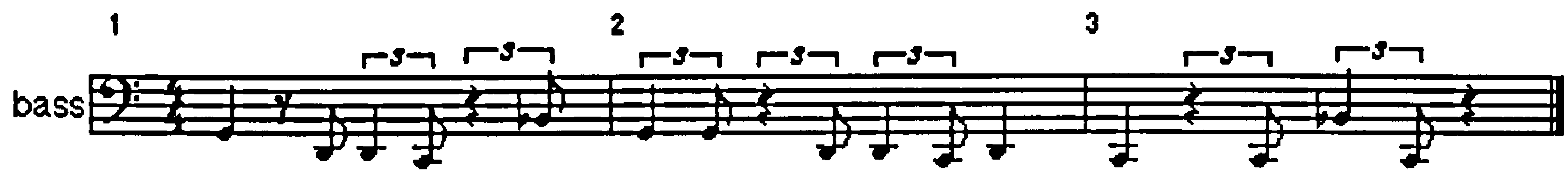


Figure 8-20: Extract from "Hair Spider", verse 2, bass line

Although both sections are different (demonstrating the affect of the RPM) they sound fairly similar. Far from being unpredictable, the bass rhythms are the same for each verse, and with the four pitches all within an octave, the possibility for any surprising melodic patterns is somewhat reduced. Placing it within a standardised structure enhances this predictability further. This result may be perceived as quasiorder, although the random bass pitches are not.

Initially, a funk riff shared between guitar and bass grounds this, over which a MIDI glockenspiel on a random arpeggiator setting undulates. The arpeggiator effect works by performing a chord one note at a time, usually in an ascending or descending pattern, to a specified rhythm. The random setting causes the notes of the chord to be performed in a random order, although it is still necessary to fix rhythm. At 2:28, the bass and the glockenspiel are put through a chorus effect, the rate of which is gradually increased causing a pitch to wobble dramatically as the section builds. It stops at 2:41 when a harmonica put through a delay effect is heard over a repeated two violins. There is no synchronization between the harmonica and the violins, so that although it is not actually random, it is intended the combination is perceived as such. This signals a complete break from the standardised structure that has dominated up to this point. At 2:53, repeated glissandi in low register go in and out of phase with the delayed harmonica.

From 3:02 onwards, a range of sounds, deliberately positioned to sound random according to personal preference, accompany the violins.

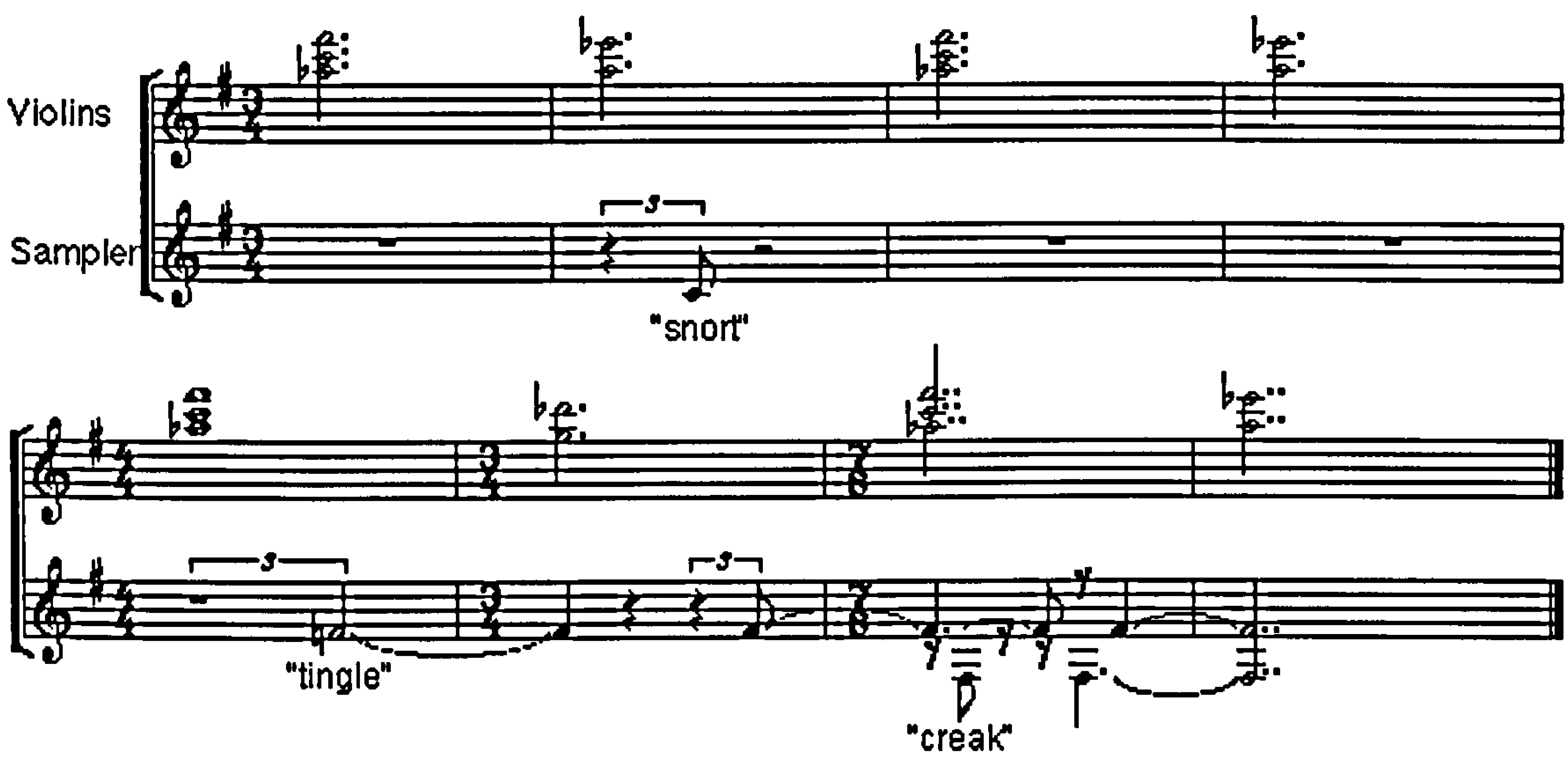


Figure 8-21: The violin and sampled sounds at 3:02

As the violins die away, these unpredictable sounds become the main focus. There is no pattern to how or when they sound, with the possible exception of comic timing; either way, they are organised subjectively. As can be seen in *figure 8-22* the types of sounds used are diverse. Some of them are identifiably comical, especially the vocal and animal noises. The intention was to construct something that sounded both random and ordered at once. Each sound is a singularity, and in that sense, random; however, the response to hearing many singularities in quick succession is to group them together, i.e., the proximity principle in Gestalt theory. The section eventually grinds to a halt (the sound is slowed down) and is replaced by a rather frenzied section at 4:43. The pitches of the glissandi section at 2:53 are used here to trigger the percussion pattern. As a process of substitution, it draws parallels with a number of other quasirandom processes, e.g. Simple Substitution Ciphers (see page 123).

At 5:00, the high pitched "chipping" sound, which seems at times to follow a rhythm, is part of a drum beat generated using the random riff generator (see page 194) passed through a ring modulator. Notes played at random on the guitar were subjected to modification by a random modulator, causing pitch to wobble unpredictably.

APPENDIX B

BINARY GRIDS

9.1 TWELVE NOTE BINARY SEQUENCE (EXPTS I AND II)

		8	**3**	**6**	**11**	**10**	**1**	**2**	**7**	**12**	**5**	**4**	**9**
	8	1001	0100	0111	1100	1011	0010	0011	**1000**	1101	0110	0101	1010
	3	0100	1010	**0011**	1110	0101	1001	0001	1100	0110	1011	0010	1101
	6	1010	0101	0001	1111	0010	**1100**	1000	1110	0011	0101	1001	0110
	11	0101	0010	1000	1111	1001	0110	0100	0111	0001	1010	**1100**	1011
	10	1010	1001	0100	0111	1100	1011	0010	0011	1000	**1101**	0110	0101
O	1	**1101**	0100	1010	0011	1110	0101	1001	0001	1100	0110	1011	0010
	2	0110	**1010**	0101	0001	1111	0010	1100	1000	1110	0011	0101	1001
	7	1011	0101	0010	1000	1111	1001	**0110**	0100	0111	0001	1010	1100
	12	0101	1010	1001	0100	0111	1100	1011	0010	0011	1000	1101	**0110**
	5	0010	1101	0100	1010	**0011**	1110	0101	1001	0001	1100	0110	1011
	4	1001	0110	1010	**0101**	0001	1111	0010	1100	1000	1110	0011	0101
	9	1100	1011	0101	0010	1000	1111	1001	0110	**0100**	0111	0001	1010
	6	0110	0101	1010	1001	0100	**0111**	1100	1011	0010	0011	1000	1101
	11	1011	0010	1101	0100	1010	0011	1110	0101	1001	0001	**1100**	0110
	8	0101	1001	0110	1010	0101	0001	1111	**0010**	1100	1000	1110	0011
	3	1010	1100	**1011**	0101	0010	1000	1111	1001	0110	0100	0111	0001
	4	1101	0110	0101	**1010**	1001	0100	0111	1100	1011	0010	0011	1000
	1	**0110**	1011	0010	1101	0100	1010	0011	1110	0101	1001	0001	1100
I	12	0011	0101	1001	0110	1010	0101	0001	1111	0010	1100	1000	**1110**
	7	0001	1010	1100	1011	0101	0010	**1000**	1111	1001	0110	0100	0111
	2	1000	**1101**	0110	0101	1010	1001	0100	0111	1100	1011	0010	0011
	9	1100	0110	1011	0010	1101	0100	1010	0011	**1110**	0101	1001	0001
	10	1110	0011	0101	1001	0110	1010	0101	0001	1111	**0010**	1100	1000
	5	0111	0001	1010	1100	**1011**	0101	0010	1000	1111	1001	0110	0100
	9	0011	1000	1101	0110	0101	1010	1001	0100	**0111**	1100	1011	0010
	4	0001	1100	0110	**1011**	0010	1101	0100	1010	0011	1110	0101	1001
	5	1000	1110	0011	0101	**1001**	0110	1010	0101	0001	1111	0010	1100
	12	0100	0111	0001	1010	1100	1011	0101	0010	1000	1111	1001	**0110**
	7	0010	0011	1000	1101	0110	0101	**1010**	1001	0100	0111	1100	1011
	2	1001	**0001**	1100	0110	1011	0010	1101	0100	1010	0011	1110	0101
	1	**1100**	1000	1110	0011	0101	1001	0110	1010	0101	0001	1111	0010
R	10	0110	0100	0111	0001	1010	1100	1011	0101	0010	**1000**	1111	1001
	11	1011	0010	0011	1000	1101	0110	0101	1010	1001	0100	**0111**	1100
	6	0101	1001	0001	1100	0110	**1011**	0010	1101	0100	1010	0011	1110
	3	0010	1100	**1000**	1110	0011	0101	1001	0110	1010	0101	0001	1111
	8	1001	0110	0100	0111	0001	1010	1100	**1011**	0101	0010	1000	1111
	5	1100	1011	0010	0011	**1000**	1101	0110	0101	1010	1001	0100	0111
	10	1110	0101	1001	0001	1100	0110	1011	0010	1101	**0100**	1010	0011
	9	1111	0010	1100	1000	1110	0011	0101	1001	**0110**	1010	0101	0001
	2	1111	**1001**	0110	0100	0111	0001	1010	1100	1011	0101	0010	1000
	7	0111	1100	1011	0010	0011	1000	**1101**	0110	0101	1010	1001	0100
	12	0011	1110	0101	1001	0001	1100	0110	1011	0010	1101	0100	**1010**
	1	**0001**	1111	0010	1100	1000	1110	0011	0101	1001	0110	1010	0101
	4	1000	1111	1001	**0110**	0100	0111	0001	1010	1100	1011	0101	0010
RI	3	0100	0111	**1100**	1011	0010	0011	1000	1101	0110	0101	1010	1001
	8	1010	0011	1110	0101	1001	0001	1100	**0110**	1011	0010	1101	0100
	11	0101	0001	1111	0010	1100	1000	1110	0011	0101	1001	**0110**	1010
	6	0010	1000	1111	1001	0110	**0100**	0111	0001	1010	1100	1011	0101

9.2 EIGHT NOTE BINARY SEQUENCE (EXPT III, SERIES i)

O	3	4	8	6	1	7	2	5
I	7	6	2	4	1	3	8	5
R	5	2	7	1	6	8	4	3
RI	5	8	3	1	4	2	6	7

3	1010	1011	**0111**	0101	1000	0110	1001	0100
4	0101	0101	1011	**1010**	1100	0011	0100	1010
8	0010	1010	1101	1101	0110	0001	1010	**0101**
6	1001	0101	0110	1110	1011	**0000**	1101	0010
1	**0100**	1010	1011	0111	0101	1000	0110	1001
7	1010	0101	0101	1011	1010	1100	**0011**	0100
2	0101	**0010**	1010	1101	1101	0110	0001	1010
5	0010	1001	0101	0110	**1110**	1011	0000	1101
7	1001	0100	1010	1011	0111	0101	**1000**	0110
6	0100	1010	0101	0101	1011	**1010**	1100	0011
2	1010	**0101**	0010	1010	1101	1101	0110	0001
4	1101	0010	1001	**0101**	0110	1110	1011	0000
1	**0110**	1001	0100	1010	1011	0111	0101	1000
3	0011	0100	**1010**	0101	0101	1011	1010	1100
8	0001	1010	0101	0010	1010	1101	1101	**0110**
5	0000	1101	0010	1001	**0101**	0110	1110	1011
5	1000	0110	1001	0100	**1010**	1011	0111	0101
2	1100	**0011**	0100	1010	0101	0101	1011	1010
7	0110	0001	1010	0101	0010	1010	**1101**	1101
1	**1011**	0000	1101	0010	1001	0101	0110	1110
6	0101	1000	0110	1001	0100	**1010**	1011	0111
8	1010	1100	0011	0100	1010	0101	0101	**1011**
4	1101	0110	0001	**1010**	0101	0010	1010	1101
3	1110	1011	**0000**	1101	0010	1001	0101	0110
5	0111	0101	1000	0110	**1001**	0100	1010	1011
8	1011	1010	1100	0011	0100	1010	0101	**0101**
3	1101	1101	**0110**	0001	1010	0101	0010	1010
1	**0110**	1110	1011	0000	1101	0010	1001	0101
4	1011	0111	0101	**1000**	0110	1001	0100	1010
2	0101	**1011**	1010	1100	0011	0100	1010	0101
6	1010	1101	1101	0110	0001	**1010**	0101	0010
7	0101	0110	1110	1011	0000	1101	**0010**	1001

Drum Pattern

SG1	1101	0101	0110	1011
SG2	1110	0011	1101	0101
SG3	0101	1101	1110	0011
SG4	0110	1011	0101	1101
SG5	0101	1101	1110	0011
SG6	0110	1011	0101	1101
SG7	1101	0101	0110	1011
SG8	1110	0011	1101	0101

9.3 EIGHT NOTE BINARY SEQUENCE (EXPT III, SERIES ii)

O	3	4	8	6	1	7	2	5
I	7	6	2	4	1	3	8	5
R	5	2	7	1	6	8	4	3
RI	5	8	3	1	4	2	6	7

3	0010	0011	**0111**	0101	0000	0110	0001	0100
4	0001	0001	1011	**1010**	1000	0011	0000	1010
8	0000	1000	1101	1101	0100	0001	1000	**0101**
6	1000	0100	0110	1110	1010	**0000**	1100	0010
1	**0100**	0010	0011	0111	0101	0000	0110	0001
7	1010	0001	0001	1011	1010	1000	**0011**	0000
2	0101	**0000**	1000	1101	1101	0100	0001	1000
5	0010	1000	0100	0110	**1110**	1010	0000	1100
7	0001	0100	0010	0011	0111	0101	**0000**	0110
6	0000	1010	0001	0001	1011	**1010**	1000	0011
2	1000	**0101**	0000	1000	1101	1101	0100	0001
4	1100	0010	1000	**0100**	0110	1110	1010	0000
1	**0110**	0001	0100	0010	0011	0111	0101	0000
3	0011	0000	**1010**	0001	0001	1011	1010	1000
8	0001	1000	0101	0000	1000	1101	1101	**0100**
5	0000	1100	0010	1000	**0100**	0110	1110	1010
5	0000	0110	0001	0100	**0010**	0011	0111	0101
2	1000	**0011**	0000	1010	0001	0001	1011	1010
7	0100	0001	1000	0101	0000	1000	**1101**	1101
1	**1010**	0000	1100	0010	1000	0100	0110	1110
6	0101	0000	0110	0001	**0100**	0010	0011	0111
8	1010	1000	0011	0000	1010	0001	0001	**1011**
4	1101	0100	0001	**1000**	0101	0000	1000	1101
3	1110	1010	**0000**	1100	0010	1000	0100	0110
5	0111	0101	0000	0110	**0001**	0100	0010	0011
8	1011	1010	1000	0011	0000	1010	0001	**0001**
3	1101	1101	**0100**	0001	1000	0101	0000	1000
1	**0110**	1110	1010	0000	1100	0010	1000	0100
4	0011	0111	0101	**0000**	0110	0001	0100	0010
2	0001	**1011**	1010	1000	0011	0000	1010	0001
6	1000	1101	1101	0100	0001	**1000**	0101	0000
7	0100	0110	1110	1010	0000	1100	**0010**	1000

Drum Pattern

SG1	0010	0101	1001	1011
SG2	0001	1100	0010	0101
SG3	1010	0010	0001	1100
SG4	1001	1011	1010	0010
SG5	1010	0110	0001	1100
SG6	1001	1011	1010	0010
SG7	0010	0101	1001	1011
SG8	0001	1100	0010	0101

9.4 EIGHT NOTE BINARY SEQUENCE (EXPT III, SERIES iii)

O	3	4	1	6	1	1	2	5
I	1	6	2	4	1	3	1	5
R	5	2	1	1	6	1	4	3
RI	5	1	3	1	4	2	6	1

3	0010	0011	**0000**	0101	0000	0000	0001	0100
4	0001	0001	1000	**0010**	1000	0000	0000	1010
8	0000	1000	1100	0001	0100	0000	0000	**0101**
6	1000	0100	0110	0000	1010	**0000**	0000	0010
1	**0100**	0010	0011	0000	0101	0000	0000	0001
7	1010	0001	0001	1000	0010	1000	**0000**	0000
2	0101	**0000**	1000	1100	0001	0100	0000	0000
5	0010	1000	0100	0110	**0000**	1010	0000	0000
7	0001	0100	0010	0011	0000	0101	**0000**	0000
6	0000	1010	0001	0001	1000	**0010**	1000	0000
2	0000	**0101**	0000	1000	1100	0001	0100	0000
4	0000	0010	1000	**0100**	0110	0000	1010	0000
1	**0000**	0001	0100	0010	0011	0000	0101	0000
3	0000	0000	**1010**	0001	0001	1000	0010	1000
8	0000	0000	0101	0000	1000	1100	0001	**0100**
5	0000	0000	0010	1000	**0100**	0110	0000	1010
5	0000	0000	0001	0100	**0010**	0011	0000	0101
2	1000	**0000**	0000	1010	0001	0001	1000	0010
7	0100	0000	0000	0101	0000	1000	**1100**	0001
1	**1010**	0000	0000	0010	1000	0100	0110	0000
6	0101	0000	0000	0001	0100	**0010**	0011	0000
8	0010	1000	0000	0000	1010	0001	0001	**1000**
4	0001	0100	0000	**0000**	0101	0000	1000	1100
3	0000	1010	**0000**	0000	0010	1000	0100	0110
5	0000	0101	0000	0000	**0001**	0100	0010	0011
8	1000	0010	1000	0000	0000	1010	0001	**0001**
3	1100	0001	**0100**	0000	0000	0101	0000	1000
1	**0110**	0000	1010	0000	0000	0010	1000	0100
4	0011	0000	0101	**0000**	0000	0001	0100	0010
2	0001	**1000**	0010	1000	0000	0000	1010	0001
6	1000	1100	0001	0100	0000	**0000**	0101	0000
7	0100	0110	0000	1010	0000	0000	**0010**	1000

Numbers 7 and 8 are both substituted for 1 (0000) creating a bias toward zero.

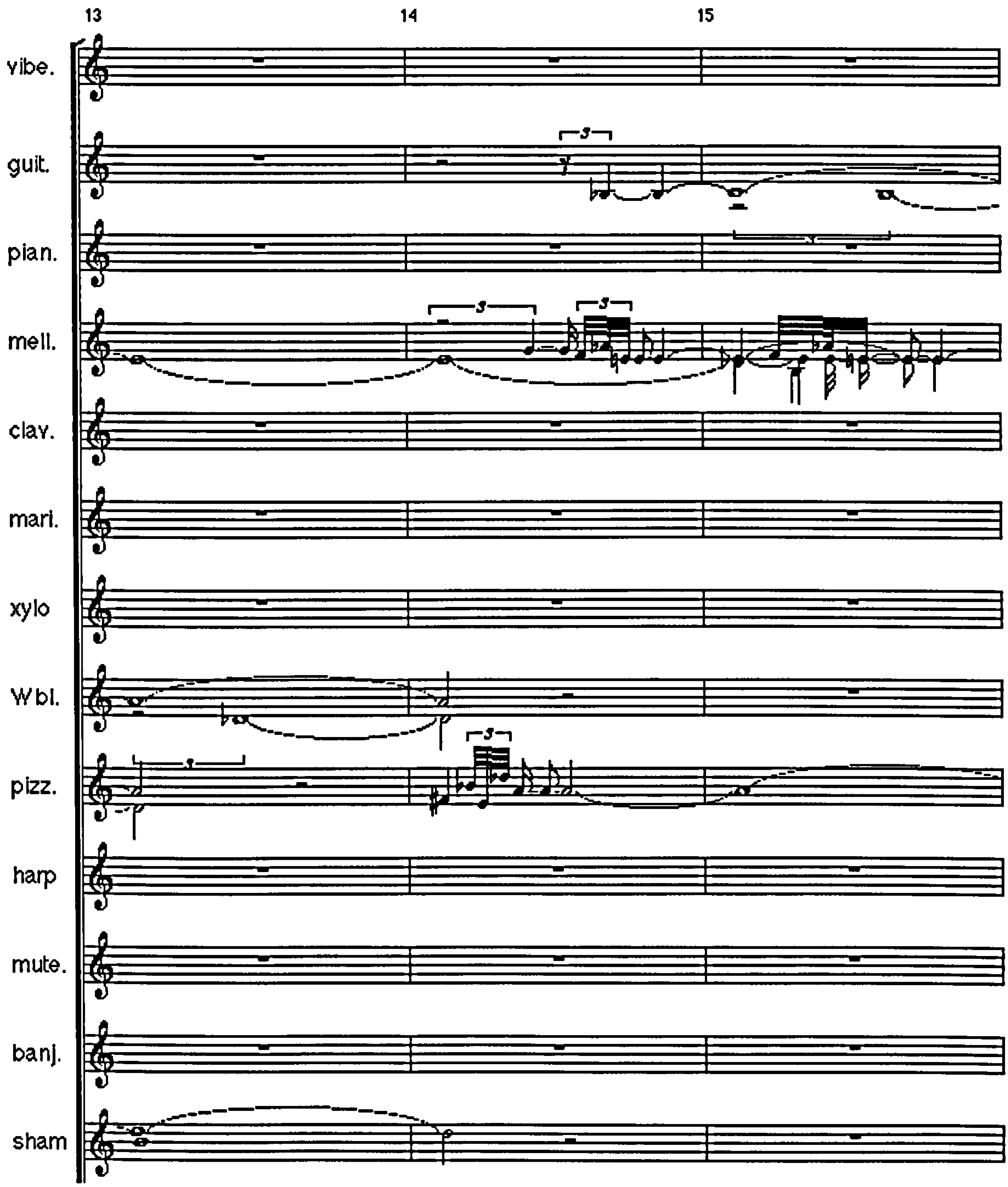
Drum Pattern

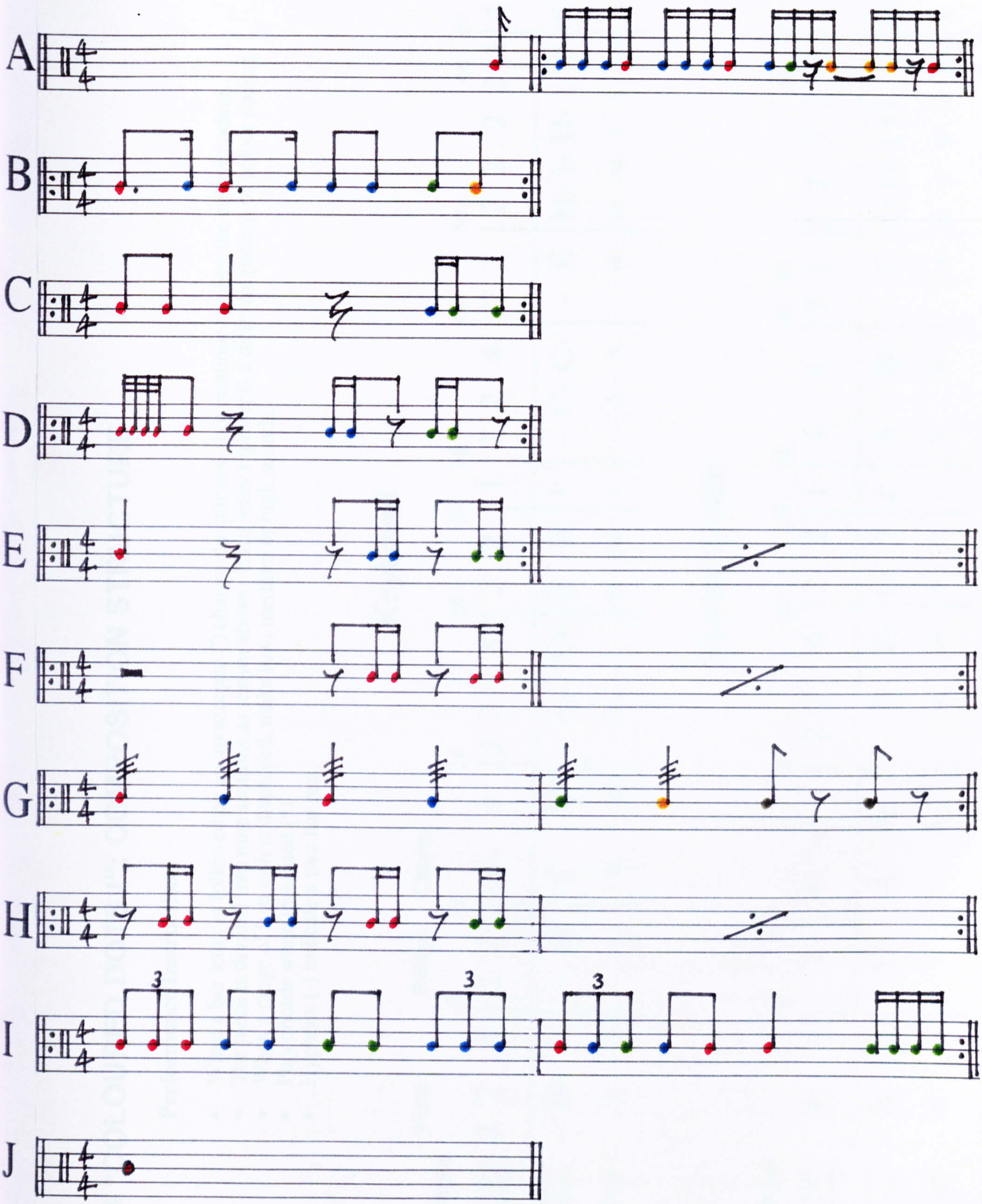
SG1	0010	0101	1100	0100
SG2	0001	1000	0010	0101
SG3	0000	0110	0001	1000
SG4	1100	0100	0000	0110
SG5	0000	0110	0001	1000
SG6	1100	0100	0000	0110
SG7	0010	0101	1100	0100
SG8	0001	1000	0010	0101

APPENDIX C

SCORES AND EXTRACTS

10.1 CRYPTOGRAPHIC SCORE EXTRACT



10.2 "COLOURED DOTS I": SCORE

10.3 "COLOURED DOTS I": COMPOSITION STRUCTURE

Performance Instructions

- When a bar letter is followed by an apostrophe (') change the pitches - but continue to obey the colour coding.
- The piece is divided into nine sections as shown above. Each letter represents a different pattern of colour coding.
- When a range of l, m or h is displayed, make low, medium or high sounds.
- Play chords when indicated (*)
- Hyphens (-) indicate a two bar rest.

Keyboard

Tempo=90bpm

	Verse			Bridge		Chorus																	
				9		13		21			29		37	38			46		50			66	67
Number of times bars are repeated:	2	2	4	2	2	4	4	2	2	4	2	2	1	2	2	4	2	2	2	2	2	2	1	4
Unit of Repetition:	-	B*	C	-	E*	C	B	-	E*	D*	H	H'	J	-	C*	C*'	-	E	H*	I*	H*	I*	J	E
Range:		h	h		m	m	m		h	l	m	m	l		h	h		m	m	m	h	h	m	l

Electric Guitar

Tempo=90bpm

			9	13		21			29		37	38		46	50					66	67
Number of times bars are repeated:	4	4	4	4	4	2	2	4	2	2	1	4	4	2	2	2	2	2	2	1	4
Unit of Repetition:	A	B	D*	A	A	-	F*	F*'	G	I	J	A*	B*	-	F	G	G'	I	G	J	D
Range:	m	m	l	h	h		m	m	h	h	l	h	m		m	h	h	m	m	m	l

Electric Bass

Tempo=90bpm

Bar				9		13		21		29		37	38			46	50				66	67
Number of times bars are repeated:	2	2	4	2	2	4	4	4	4	2	2	1	2	2	4	4	2	2	2	2	1	4
Unit of Repetition:	-	C	A	-	F	B	C	D	E	I	G	J	-	B	A	D	I	H	G	H	J	F
Range:		m	l		h	m	l	h	h	l	l	l		m	l	m	l	l	l	l	m	l

Drum Kit

Performance Instructions

Each letter has a different set of drums representing the colour coding. Cymbals/hi-hats may be added in a traditional manner, to enhance the feel of the music.When a repeat of four is indicated, play the corresponding bar four times. When a repeat of two is indicated, play the corresponding bar twice.

Tempo=90bpm

Bar				9	13		21		29		37	38			46	50				66	67
Number of times bars are repeated:	2	2	4	4	4	4	4	4	2	2	1	2	2	4	4	2	2	2	2	1	4
Unit of Repetition:	-	C	A	D	B	B	D	E	G	H	J	-	C	A	D	H	G	H	G	J	D

10.4 "COLOURED DOTS II": SCORE

10.5 "COLOURED DOTS II": COMPOSITION STRUCTURE

Letters refer to each coloured dot pattern (or unit of repetition); hyphens indicate a period of one bar rest. The numbers following each letter or hyphen indicate the number of repeats each pattern or period of rest undergoes.

DRUMS

1)	A 4	B 4		
2)	J 2	I 1		
3)	A 3	C 1	E 3	F 1
4)	J 4	D 1	I 1	- 2
5)	F 4			
6)	D 2	J 1	H 1	G 1

KEYBOARD

1)	- 4	A 2	C 4	
2)	- 4	I 1		
3)	A 4	- 6	F 1	
4)	K 4	- 2	I 1	G 1
5)	F 4			
6)	D 2	L 1	H 1	G 1

GUITAR

1)	A 4	- 4	B 2	
2)	K 2	I 1		
3)	C 4	F4		
4)	K 4	- 2	I 1	G 1
5)	A 4			
6)	D 2	K 1	H 1	G 1

BASS

1)	- 4	A 2	B 4	
2)	L 2	I 1		
3)	C 4	E 4		
4)	L 4	D 1	I 1	- 2
5)	A 4			
6)	I 2	I1	H 1	G 1

APPENDIX D

INTERVIEWS AND SURVEYS

11.1 THE BANNED MEMBERS INTERVIEW

Peter Thorley: Bass Guitar

ED (Evil Dick): This is Pete, the bass player of the Banned Members...OK... What were your first impressions upon your initial encounter with the coloured dots pieces?

PT (Peter Thorley): Yeah... well, the coloured dots piece was the first one I heard because it was on the website wasn't it?

ED: Yeah, probably.

PT: I think it was "Sweaty Retard"; I thought... that's a weird name.

ED: When you were listening to it, before you knew how it was done, how did you perceive it?

PT: I actually thought it was laid out; I noticed that both you and Guy do play some of the same riffs in the same keys sometimes and because I actually heard that when I first listened to it, I did assume that it was laid out, it was just intentionally out of key. When you actually introduced the concept to me – you included an explanation of the music on the *Rock 'n' Random* CD [available from http://polemicmusic.com] – I think it was my dad who caught on before me. He realised how it was supposed to work. And to begin with it was quite difficult to figure out...

ED: How did you feel playing those pieces in front of people? Did that affect you? Did you have, sort of, mental barriers? Were you worried about being humiliated in front of an audience?

PT: Not really ‘cus, as I said, dad spoke about it quite a lot when I first heard it and my dad doesn’t really appreciate art so much, but when he was able to take it for what it was I did feel that it wouldn’t be quite so nerve-racking. But the first gig, I have to admit, I was quite nervous.

ED: Is that because what you were going to play, or because you were worried about the audience reacting badly...or something like that?

PT: I wasn’t really worried about the audience reacting badly, ‘cus I’ve had the audience react badly before in other circumstances; I think you get used to it and when you’re intentionally playing something that’s completely unconventional, I think most people won’t react so harshly. It’s the difference between original bands and cover bands; people clap for original material bands because it’s something new, they haven’t heard it before, so they can’t judge it too harshly but people are always more discerning with cover bands because they expect something from them, it’s got to sound how they want it to. With us, people didn’t really know what to expect or how to react. When I got the reaction from my parents afterwards, they couldn’t tell if it was out of key because there was so much going on.

ED: Had you ever free improvised or improvised before?

PT: Not to the extent we do. I’ve improvised in the normal manner, but I’ve never really improvised without scales. It’s not even a matter of improvising without a melody; it’s improvising with sounds more than anything else, which I hadn’t really done before. Other people have talked about making different sounds on the bass, but I think the more outlandish part of it for me was playing something, which didn’t have a key, or melody, or anything to it, that was completely random...

ED: One of the things that has surprised me is that some of those free improvisations we’ve done have ended up being the things that have got the biggest applause, certainly on some of the recordings I’ve got.

PT: It always reminded me of Pink Floyd (ED thinks: ouch!) because they liked to drop in with weird sounds and it’s one of those things, when it’s done well live it can look and sound really professional. I think that’s probably what draws people in.

ED: Well, it’s quite unusual as well in those venues.

PT: Sometimes when we're doing improvisations they're completely structured, we use similar sounds each time, but other times, when maybe we're more awake or more on the ball and we do something that's completely unique.

ED: Well, there's the bit in "Who's Your Daddy" which, although it's improvised, tends to be the same idea each time, but there have been a few occasions when I've said, "let's do a free improvisation" and we do for five minutes – it's quite brave, I think.

PT: In those situations we're more likely to experiment a lot more; try something different and when it comes out properly it sounds good.

ED: Are you aware of what everyone else is doing in those free improvisations?

PT: More so now than when I began, I think, I've been careful to listen to what's going on around me.

ED: Does that mean you find yourself playing with it or against it, or...?

PT: I think, with all due respect to everyone else in the band, there's sometimes a lot of stuff going on, and there are times when I feel I personally have to drop-out, just to make sure the sound doesn't get overloaded.

ED: That's very worthy of you.

PT: It's something I'm more conscious of now than I was at the beginning. It varies, there are times when almost everyone drops out and I feel I have to fill in. Whether I'm right or not is purely debatable.

ED: It is indeed purely debatable. There aren't really any recognisable song structures in what we do; they are more composition based, more like pieces than songs.

PT: Maybe it's what I've been brought up on, but I do find I'm used to the structures. I do think there are discernable structures there, but that's probably because I've been brought up on prog rock.

ED: So do you think other people might have difficulty when they first hear it maybe?

PT: It's always odd when I talk to other people because when you've had such a different musical upbringing, as I have, you find it odd to speak to other people who've maybe only ever listened to what's in the charts and they're used to a completely different way of structuring music.

ED: Is this because chart music is all verse, chorus, verse, chorus, middle eight...

PT: If you take any Britney Spears song it's exactly the same as any other.

ED: But what about something that's a bit more messed up, like turntable stuff, where they're chopping up other peoples' songs... is that any better?

PT: I'm personally not very interested in it; I don't think it requires any musical skill. But in that way you could say people are being a lot more creative about their music, particularly when they're taken samples of other peoples songs and putting them in their own compositions, they're taking the music they like and expressing it in their own way. I personally don't think that, obviously, because they've messed up some of my favourite songs!

ED: Do you think there are any limits as to how far we can go with randomness, if we're playing the Shed and places like that? Do you think that by pushing a boundary it makes what we do more legitimate and people appreciate it more?

PT: I can't really say – that's a difficult question.

ED: Are you aware of there being degrees of randomness?

PT: I know there are degrees in chaos theory...but not about randomness...

ED: Do you think the coloured dots pieces are as random as the free improvisation bits?

PT: It depends, a definition of randomness is that anything can happen, and that also includes everyone playing in tune with each other!

ED: One of the ways I think about it in composition is... you have ways of controlling randomness, or you have parameters in music and you might control some of them and leave others to chance. So I would consider the free improvisations, where we haven't planned anything as more random than the coloured dots pieces, where we have very fixed rhythmical aspect.

PT: Yeah, it's hard to say. When it comes to free improvisations, anything could happen, but it's not to a melody; a lot of it is sound. I think the coloured dots pieces could possibly sound more random than free improvisations. In the free improvisations, a lot of the time I say to myself I'm not going to make a tune, I'm going to make noises out of the bass...

ED: So do you think that maybe people listening to it think the coloured dots pieces are more random than the free improvisations?

PT: Yes – because most people are more attuned to melody and tune than they are to sound.

ED: So you think they pick up on the melodies of the coloured dots pieces and think "they don't make any sense" so they're perceived as more random?

PT: Yeah.

ED: People are so attuned to melody, when they hear it messed up they think "Wow, it's really random".

PT: Yeah

ED: Interesting...

Peter Gregory: Drums

ED: Pete, you're one of the more experienced members of the group, or at least, you go back a long way...

PG (Peter Gregory): That's a better way of putting it!

ED: Yes...your experience of bands has included free improvisation before. But how do you feel about going out and playing improvised music in front of pub audiences?

PG: It's daunting, but it when it works it's very satisfying.

ED: So you're aware that what we're doing is different from what a lot of other bands are doing in Leicester?

PG: Well... yes, definitely.

ED: OK. You've suggested we introduce more familiar song structures. Why do you think that's a good idea?

PG: Not in the sense of getting away from the more extreme elements of what we do; what I think it's all about is a question of experimenting with the pacing of the set. And finding what seems to work for us. I think that what you can't do is expose people to too much indulgent experimentation when they're on a night out, because there's only a certain amount of it that they'll be prepared to take. You have to pace everything...

ED: So, you're saying that the role of the band is very much as an entertainment thing for other people to enjoy, in that sense...

PG: Yes. I think it's hard to avoid that's the conclusion when you're out there on the stage in front of people.

ED: Do you feel, in that case, that the venue is very much dictating, or at least having a big say in what you can do when you're there?

PG: I think that's very much the case. If people were coming specifically to see us – if the band acquired a reputation whereby people were going out and buying tickets to come and see us at a venue – then we'd get more freedom to dictate what we can do. But when you're attending a regular venue where there are bands on seven nights a week, people will attend the venue because they know they can predict a certain standard of entertainment, a certain approach to entertainment. I think it's hard to pull them too far out of that without being unduly provocative.

ED: Do you think there's a problem with that undue provocation? I've been reading about Mike Westbrook, who's a figure from jazz, but he was saying there was a point in time when he was going out of his way, wholeheartedly, to fuck off the audience. But not because he didn't want them to enjoy it, basically, the path he was on was irritating them.

PG: He wanted to challenge their assumptions.

ED: Well, he wasn't even doing that. He had an idea that he wanted to pursue, it just so happened audiences that were used to hearing him do jazz weren't up for it, and they'd be rude and they'd heckle or they'd leave. Even the musicians would leave off the stage 'cus they'd get fed up with it.

PG: When musicians start leaving off the stage, then you've got a problem.

ED: Well, yeah, but that kind of added to this great myth of Mike Westbrook, 'cus he's now got this great following because that's what he went out and did. Do you think there's anything to say by that, in the sense that, the more you push certain boundaries, although you might in the short term offend people, in the long the term it's possibly a good thing to do...not just in terms of career...

PG: Yeah, I mean...I think, in terms of career, one goes out and plays music for enjoyment and it's nice to get appreciated by people, but it's not the total be all and end all of everything. If I believed strongly enough in what we're doing then I'd be quite happy to keep on doing it no matter how extreme it gets. When I made the suggestion that we should put more song structures into the over all thing, it was really more a question of saying, not that I think it's a bad thing to do overall – to go out and improvise in peoples faces for half-an-hour – but it's good to play to your own strengths. And I think that you're a very good composer of song structures and that you write things that are very good to listen to. I think that including an element of that in the set is a good idea.

ED: So you want a balance between improvisation and composed stuff.

PG: Balance is important.

ED: Pete (Thorley) said something quite interesting. He said that people would find the free improvisation bits easier to get on with because in the coloured dots pieces people go "wow, that's random" – the pitches are all over the place – but in the free improvisation bits, because it's all to do with sound, and a bit weird, people don't have much of a problem with it. Do you think the coloured dots pieces sound more random?

PG: Yes – I think that there are parts of the coloured dots pieces that are much more aggressively in your face – from the audiences' point of view – than the free improvisation that we do. I think that some of the stand alone free improvisation pieces have actually been amongst the most entertaining things that we've done live, and the tapes of the gigs actually tend to bare that out.

ED: Yeah, in the applause... I think that's true.

PG: In improvisation, people are pursuing their own habits to certain extent, I know we're trying not to do that, but we are doing... but the coloured dots pieces, what they tend to do – when they're very structured – is challenge the habits not only of the audience, but also of the musicians at the same time.

ED: In the free improvisation bits, are you listening to the other members of the band or are you on your own line of thought.

PG: Yeah – I'm trying to listen to what other people are doing but it doesn't always happen. Sometimes you end up listening to yourself. And sometimes that can work. And very often you can play a passage of improvisation and not be aware of particularly listening to what's going on, but then you hear the tape back afterwards and you find that you were listening to people and people were listening to you, far more than you thought they were at the time!

ED: Do you ever play against what everyone else is doing?

PG: Yes – probably. As a drummer I try to strike a balance between playing with and against people. And that works with improvisation as well as structured songs.

ED: So were you daunted at all about going out and playing free improvisation in front of an audience?

PG: Yep.

ED: You were daunted?

PG: Yep.

ED: What was daunting? Was it the fact that you were trying to win an audience over or were you just frightened the audience would say "bollocks!" or what?

PG: Absolutely both.

ED: OK. Have you got over that at all?

PG: Yes. I'm more confident; from the moment we first gigged as a three piece and people liked it, that was a big hurdle for an unusual band to get over, and that gives you a whole lot of confidence. If you know one audience likes you, and you go out and you have a bad night, then you know it was either a bad performance or a bad audience.

ED: Is a bad audience one that boos or one that is just indifferent.

PG: No – it's an audience composed of cretins and morons.

ED: But wouldn't you rather get an emotional reaction from people, even if it's "this is a load of bollocks!" rather that people just ignoring you.

PG: I'm not terribly interested in getting an emotional reaction of "this is a load of bollocks". It isn't really what I started playing musical instruments to experience.

ED: OK.

Guy Wilkinson: Electric Guitar

ED: We've been talking about improvisation and what it's like playing to an audience that's not use to hearing it. Did you have any apprehensions about doing that?

GW (Guy Wilkinson): Not really. You occasionally get hecklers at The Shed, don't you…

ED: Yeah – so would that affect you?

GW: No, I would have ignored it anyway.

ED: So, we've been doing these coloured dots pieces. Now, you were there right at the beginning. What were your first impressions?

GW: It was quite different and quite amusing.

ED: Did you think we'd ever go out and play them? Did you think how they might go down?

GW: I didn't really think how they might go down, but I did want to go out and play them.

ED: What do you think is the most random thing we're doing? Do you think there's a song, which stands out as particularly random?

GW: Well, the coloured dots ones.

ED: We have the coloured dots pieces and free improvisation... do you think one is more random than the other?

GW: Well, the impression I got from speaking to my friends after the gigs is that they all thought the most random one of the lot was "Who's Your Daddy"... and not the coloured dots ones.

ED: Well, that has got a lot of quite free improvisation in it. Which gig was that at?

GW: The Charlotte gigs.

ED: Right. So what about your guitar? The one you have today is renown for going out of tune regularly... do you think this adds anything to the sound of the band? The random element, maybe?

GW: Well, the intonation on it isn't that good, at the high end it does seem to be out of tune permanently, anyway. Which is mainly because the original bridge on it was crap and died, and the new bridge on it is a lot better, but it's not quite in the right place!

ED: I see. Do you think that if we pushed the randomness further it would be detrimental to us getting anywhere?

GW: Not really.

ED: So you think it's a good thing.

GW: Yeah – it's a bit different. Sometimes things that are a bit different actually do far better than the things that are all the same. At least it's not stagnating.

ED: No. OK... let's leave it there.

11.2 BBC RADIO LEICESTER INTERVIEW EVIL DICK

BBC Radio Leicester Breakfast Show, Tuesday 6th May 2001, 8:55am

Jo Hollis (JH): It says here, "My humble intention is to raise the profile of experimental music before it vanishes all together into the world of academic thesis and faded memories"
ED (Evil Dick): Yeah...
JH: Is that really what you meant?
ED: Basically I think raising the profile of experimental music is always a good thing. There's a wave in the music industry to repress such fun and frolics as inventive behaviour and experimentalism...I just think it should be at a higher profile - and allowed in venues.
ED: I'm looking to find a group of people, musicians preferably, with an ability to play instruments, interested in playing unusual music. I'm not really looking for people who have a very fixed idea of what they want to do or what they want to achieve from it. There's got to be a high level of freedom for exploring different ideas. Part of it is going to be an offshoot of my PhD research.
ED: I'm using a computer system, basically a sequencer connected to keyboards and samplers. For my PhD I'm using a lot of the random facilities, which sequencers can offer to try and generate scores, and that sort of thing.
JH: And tell me about that track using all sorts of things that you found around the home.
ED: One of the tracks basically samples everyday things I've got lying around. There is an actual tin tray for a snare drum and the side of a filing cabinet for a bass drum...other things like stupid whistles and squelchy noises just to kind of like enrich the blend.
ED: I'm not looking for virtuoso performers, although if someone is a virtuoso I probably won't turn them away either...an ability to play your instrument is a good start.
JH: So where will this music take place that you're trying to achieve with the band?
ED: I'm hoping that it will be a regular gigging band. I don't want it to be hidden away. I want to take it out there and play The Shed! Huh-huh...
JH: *(Laughing)* Aim high!

ED: Oh yeah. Pub gigs especially. When you actually look at audiences, they're so indifferent, really, about what a lot of the musicians are actually doing on stage. It takes a lot to actually grab the public's attention. I think, fair enough, they just want to go out for a pleasant evening and they don't want to have this weird music pushed in their faces. But, at the same time, that can be an enjoyable experience too, I find. It would be nice if it could be taken to the stage of having a record company involved. I mean, I don't want it to turn into a kind of like Hear'Say or some *Popstars* [the ITV television programme] type scenario...you know?

JH: *(Laughs)* Heaven forbid.

ED: Heaven forbid. Spare us that.

JH: Any idea what you'll be called?

ED: Well the current title is gonna be Evil Dick and the Banned Members...but that's another story altogether...

11.3 DEMO JURY

(The track "Anchovies in the Ice Cream" *is played; the audience applauses.)*

A: Now then... Making me miss the match [for this]. What can I say? *(Starts to sing tune out loud)* Diddle-iddle-up, piddle-up piddle-up pom-pom... OK. Intense, heads, green mouse, obsessive, speed-freak-state mentality... Obsessive... staying up all night...

ED: Cartoon?

A: It's a cartoon definitely.

C: What were you trying to do?

ED: What did it sound like?

C: To be honest with you, it sounded like, ZX Spectrum computer music...

ED: Yeah? That was the intention.

C: Yeah. OK...great...brilliant... fantastic... not a lot to say... that's what it was...

(Audience mummers aghast at this flippant dismissal...)

ED: What's wrong with that?

C: Nothing's wrong with that.

ED: Good.

B: I wish it had been on at the start; this could have taken a right little twist.

A: I don't know... you've got your head round your equipment...you've...

ED: It's composition... not really the equipment. It's more about the composition.

(Silence)

ED: Originality is important, isn't it?

A: Definitely. Fragmented... collage... all good. Not a record deal. Certainly worth speaking to people in [computer] games... you know...

B: Sound design

A: Sound designing

B: It's not a song, it's not songwriting; it's just a collection of sounds.

ED: But don't other sorts of music get record deals other than songwriting, which is actually a very small part of what it [i.e., music] is all about?

C: No.

ED: No. It's actually true; other music exists!

C: What like?

ED: Free improvisers...

C: What do you mean free improvisers... what does that mean?

ED: Free improvisation...

C: Never heard of it.

ED: There's a big market

C: Never heard of it.

11.4 SURVEY QUESTIONS

a) How much did you enjoy the extract? (1=hated it, 7=loved it) 1 2 3 4 5 6 7

b) Did you like the range of sounds used in the music? Yes No

c) Which sounds/instruments did you recognise? ____________________

d) What genre (e.g. heavy metal) is this music?____________________

e) How noticeable was repetition of the following? (1=not at all, 7=very)

i) Melodic themes	1 2 3 4 5 6 7
ii) Rhythm patterns	1 2 3 4 5 6 7
iii) Phrases	1 2 3 4 5 6 7
iv) Chord progressions	1 2 3 4 5 6 7

Did you notice any repetition anywhere else?____________________

f) Over all, did the music sound structured or unstructured?
(1=unstructured, 7=structured) 1 2 3 4 5 6 7

g) How predictable was the music? (1=unpredictable, 7=predictable) 1 2 3 4 5 6 7

h) To what degree did the following sound random? (1=not random, 7=extremely random)

i) Pitches	1 2 3 4 5 6 7
ii) Rhythm	1 2 3 4 5 6 7
iii) Duration of notes/sounds	1 2 3 4 5 6 7
iv) The position in time of each note/sound	1 2 3 4 5 6 7
v) Transitions between sections	1 2 3 4 5 6 7
vi) The interplay between different instruments	1 2 3 4 5 6 7
vii) Tempo variations	1 2 3 4 5 6 7
viii) Dynamics (e.g. loud/soft)	1 2 3 4 5 6 7
ix) Harmonic Progression	1 2 3 4 5 6 7

i) How complex did the music sound? (1=simple, 7=complex) 1 2 3 4 5 6 7

j) Did the level of complexity spoil it for you? Yes No

k) How memorable/catchy was the music? (1=not at all, 7=very) 1 2 3 4 5 6 7

l) How humable was the music? (1=doh!, 7=mmm) 1 2 3 4 5 6 7

11.5 RESULTS OF SURVEY

COMPARISON OF RESULTS: GROUPS A AND B, EXTRACT 1
QUESTION H:
To what degree do the following sound random?

Group A.

Score range 1=not random, 7=extremely random	1	2	3	4	5	6	7	X	Med. score	Mean score
i) Pitches	**15**	0	0	0	0	0	0	0	1	1.0
ii) Rhythm	**13**	2	0	0	0	0	0	0	1	1.1
iii) Duration	**13**	2	0	0	0	0	0	0	**1**	1.1
iv) The positioning of notes in time	**11**	4	0	0	0	0	0	0	1	1.3
v) Transitions between sections	**12**	1	1	1	0	0	0	0	1	1.4
vi) The interplay between different instruments	**11**	4	0	0	0	0	0	0	1	1.3
vii) Tempo variations	**14**	1	0	0	0	0	0	0	1	1.1
viii) Dynamics	**13**	1	1	0	0	0	0	0	1	1.2
ix) Harmonic Progression	**13**	2	0	0	0	0	0	0	1	1.1
	TOTAL								9	10.6
	AVERAGE RESULT								**1**	1.2

Group B.

Score range 1=not random, 7=extremely random	1	2	3	4	5	6	7	X	Med. score	Mean score
i) Pitches	**15**	0	0	0	0	0	0	0	1	1.0
ii) Rhythm	**15**	0	0	0	0	0	0	0	1	1.0
iii) Duration	**14**	1	0	0	0	0	0	0	1	1.1
iv) The positioning of notes in time	**14**	1	0	0	0	0	0	0	**1**	**1.1**
v) Transitions between sections	**12**	3	0	0	0	0	0	0	**1**	**1.2**
vi) The interplay between different instruments	**12**	2	1	0	0	0	0	0	**1**	**1.3**
vii) Tempo variations	**15**	0	0	0	0	0	0	0	**1**	**1.0**
viii) Dynamics	**13**	2	0	0	0	0	0	0	**1**	**1.1**
ix) Harmonic Progression	**15**	0	0	0	0	0	0	0	**1**	**1.0**
	TOTAL								**9**	**9.8**
	AVERAGE RESULT								**1**	**1.1**

COMPARISON OF RESULTS: GROUPS A AND B, EXTRACT 2
QUESTION H:
To what degree do the following sound random?

Group A.

Score range 1=not random, 7=extremely random	1	2	3	4	5	6	7	X	Med. score	Mean score
i) Pitches	0	0	0	2	**7**	4	2	0	**5**	**5.4**
ii) Rhythm	2	0	2	4	**5**	1	1	0	**4**	**4.1**
iii) Duration	2	0	3	2	**4**	2	2	0	**5**	**4.3**
iv) The positioning of notes in time	1	1	**4**	3	3	1	1	1	**4**	**3.9**
v) Transitions between sections	0	0	3	**5**	3	3	1	0	**4**	**4.6**
vi) The interplay between different instruments	1	0	1	3	3	**4**	2	1	**5**	**5.1**
vii) Tempo variations	3	0	2	1	2	3	**4**	0	**5**	**4.6**
viii) Dynamics	**3**	**3**	**3**	2	1	1	1	1	**3**	**3.1**
ix) Harmonic Progression	1	0	0	**5**	4	1	4	0	**5**	**5.0**
	TOTAL								**40**	**40.1**
	AVERAGE RESULT								**4.4**	**4.5**

Group B.

Score range 1=not random, 7=extremely random	1	2	3	4	5	6	7	X	Med. score	Mean score
i) Pitches	0	0	1	4	**5**	1	3	0	**5**	**4.7**
ii) Rhythm	1	**4**	3	**4**	2	1	0	0	**3**	**3.3**
iii) Duration	0	2	2	2	**5**	3	0	1	**5**	**5.1**
iv) The positioning of notes in time	1	1	**4**	3	3	2	1	0	**4**	**4.1**
v) Transitions between sections	1	0	3	4	1	**5**	1	0	**4**	**4.5**
vi) The interplay between different instruments	0	1	2	**4**	3	3	1	1	**5**	**4.6**
vii) Tempo variations	1	**5**	1	2	2	3	1	0	**4**	**3.8**
viii) Dynamics	0	1	2	**7**	3	2	0	0	**4**	**4.2**
ix) Harmonic Progression	0	0	1	2	**6**	4	1	1	**5**	**5.1**
	TOTAL								**39**	**39.4**
	AVERAGE RESULT								**4.3**	**4.4**

COMPARISON OF RESULTS: GROUPS A AND B, EXTRACT 3
QUESTION H:
To what degree do the following sound random?

Group A.

Score range 1=not random, 7=extremely random	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**X**	Med. score	Mean score
i) Pitches	1	0	1	2	1	4	**5**	1	**6**	**5.4**
ii) Rhythm	0	1	0	2	3	**5**	3	1	**6**	**5.4**
iii) Duration	1	1	1	1	2	**5**	3	1	**6**	**5.1**
iv) The positioning of notes in time	0	2	1	0	**4**	3	**4**	1	**6**	**5.2**
v) Transitions between sections	0	2	0	2	2	4	**5**	0	**6**	**5.1**
vi) The interplay between different instruments	0	1	0	3	3	2	**5**	1	**6**	**5.4**
vii) Tempo variations	1	2	1	1	2	3	**4**	1	**6**	**4.9**
viii) Dynamics	0	1	0	2	3	**5**	3	1	**6**	**5.4**
ix) Harmonic Progression	0	0	1	1	1	5	**6**	1	**6**	**6.0**
	TOTAL (T)								**54**	**47.9**
	AVERAGE RESULT (T/9)								**6**	**5.3**

Group B.

Score range 1=not random, 7=extremely random	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**X**	Med. score	Mean score
i) Pitches	2	0	2	0	**5**	2	4	0	**5**	**4.9**
ii) Rhythm	1	2	0	3	3	1	**5**	0	**5**	**4.9**
iii) Duration	2	0	**4**	0	3	2	**4**	0	**5**	**4.6**
iv) The positioning of notes in time	2	1	**3**	**3**	2	1	**3**	0	**4**	**4.1**
v) Transitions between sections	2	0	0	2	**5**	3	3	0	**5**	**4.9**
vi) The interplay between different instruments	0	2	1	2	**4**	3	3	0	**5**	**4.9**
vii) Tempo variations	2	1	0	3	2	2	**4**	1	**5**	**4.7**
viii) Dynamics	2	1	3	2	1	1	**4**	1	**4**	**4.3**
ix) Harmonic Progression	**3**	2	1	2	2	1	**3**	1	**4**	**3.9**
	TOTAL (T)								**42**	**41.2**
	AVERAGE RESULT (T/9)								**4.7**	**4.6**

APPENDIX E

MISCELLANEOUS

12.1 ANALYSIS OF MANGLE FILTER

The Mangle Filter affects the amplitude and delay of its input using the average amplitude value of its input. In other words, as a signal gets louder the delay line it is running through gets longer. This can happen at a very fast rate, creating unusual and extreme filter and distortion sounds.

The results of applying the Mangle Filter to an audio signal are, to say the least, unpredictable. The mangled soundfile has numerous powerful spikes nowhere present in the original, along with smaller blemishes, crackles and pops, which add to its unpredictable characteristic. Sounds often appear to be sped up, slowed down, reversed, stretched and squashed. In fact, the Mangle Filter behaves like a quasirandom generator, using one source of data (average amplitude) to control another (delay). The delay time is extremely sensitive to changes in this amplitude, with dramatic distortions to the input signal occurring at gain increases as small as 0.01dB. This makes it impossible to pre-empt the post-mangled sound just by listening to the input signal.

Method

In order to see how the Mangle Filter works as a quasirandom generator, an experiment was devised to measure the effect of increasing the gain of the input signal. The chosen input signal was a ten second soundfile of a drumbeat (four bars at 96bpm). Audio software allowed for the amplitude of the input signal to be increased incrementally and compared to the output signal. Waveforms of the mangled sound were viewed at each stage to identify areas of interest prior to taking measurements. By comparing these in the preliminary trials based on 3.0dB steps, it became clear that such steps were too great to identify the subtle changes in the output signal occurring between 0.0dB and 10.0dB in adequate detail; therefore, within this range, further readings were taken, increasing the strength of the input signal in steps of 1.0dB. In viewing the waveforms it became apparent that the drumbeat soundfile contained more points of interest than were necessary and so the analysis was confined to a 2.50s portion, equivalent to one bar at 96bpm.

Three points, A, B and C, were chosen within this timeframe. Point A was a spike which appeared between 1.0dB and 2.0dB. It did not seem to relate to any point in the input signal. This was investigated at a magnified level (increasing the gain in 0.01dB steps) to find the exact point at which it first appeared. Point B was an audio glitch which became more pronounced as the amplitude of the input signal increased. It also acted as an approximate end-point of the sound which starts at A. Point C was the sound of a snare drum which seemed to relate to the snare drum occurring at time x_1=1.25s in the input signal.

Analysis of Results

The graph (see *figure 12-1*) clearly shows that the "randomising" quality of the Mangle Filter is based on time delays. The distance between the three curves constantly changes. Curve C goes back on itself; this means that a sound occurring at time x_2=1.50s can be the result of two different gain increases, 1.1dB and 4.4dB. The shallow slopes of the curves indicate that the slightest increase in gain can have a substantial affect on the time delay.

The original soundfile was a 10.00s long recording of a four-bar drum pattern, therefore, one bar is 2.50s long and one semiquaver is 0.16s long. The graph shows that for the first 3.0dB gain increase, C moves between 1.28s and 1.82s, a difference of 0.54s (approximately 3.5 semiquavers). Such a difference has a considerable affect on the rhythm, creating unusual subdivisions in a particularly jerky fashion.

The relationship between points A and B shows how the duration of a sound is changed by the Mangle Filter. When point A appears at 1.4dB, its duration is about 0.02s. Increasing the gain to 4.0dB (a difference of 2.6dB) and the duration is 0.24s. As this increase continues, point B is transformed from a glitch (marking point A's duration) to a powerful spike. This type of sound transformation has an influence on the rhythmical direction a mangled drum pattern takes. New percussive elements emerge from nowhere to become significant, if erratic, accents.

Another feature is the way in which the movements of the mangled beats eventually coincide with points in the input signal. Although C is directly related to the snare drum occurring in the input signal at x_1, A is on the beat at this point at 11dB gain increase.

After increasing the gain of the signal by 10.0dB, the output started to become more predictable; movements of the three points started to follow a pattern suggesting that there was a saturation point after which the quasirandom element was diminished. From this point on, louder input signals merely produced stretched out signals.

Less easy to represent with a graph is the impact on timbre caused by the contracting and stretching of the sounds. A boring drumbeat can be transformed into a fascinating, jumbled flow of sounds, and yet maintain a sense of pulse. As the gain increases, clicks, pops and glitches reveal themselves to be distorted parts of the original input signal. This example has concentrated on applying it to a rhythm; however, when used on melodic lines the affects are less noticeable, since continuous flows of pitch often do not have the amplitude variation required to drastically change the delay times.

Results

Gain/decibels	Time/seconds			
	A	B	C	C-A
-	-	0.99	1.82	0.83
+1	-	0.99	1.53	0.54
+1.39	-	0.99	1.44	0.45
+1.40	0.98	1.00	1.45	0.47
+1.44	0.98	1.00	1.44	0.46
+2	0.92	1.00	1.35	0.43
+3	0.83	1.00	1.28	0.45
+4	0.77	1.01	1.28	0.51
+5	1.08	1.36	1.61	0.53
+6	1.13	1.44	1.68	0.55
+7	1.17	1.50	1.73	0.56
+8	1.21	1.55	1.78	0.57
+9	1.22	1.58	1.81	0.59
+10	1.24	1.61	1.84	0.60
+12	1.26	1.65	1.87	0.61
+14	1.26	1.69	1.90	0.64
+20	1.28	1.78	1.94	0.66
+30	1.26	-	1.98	0.72

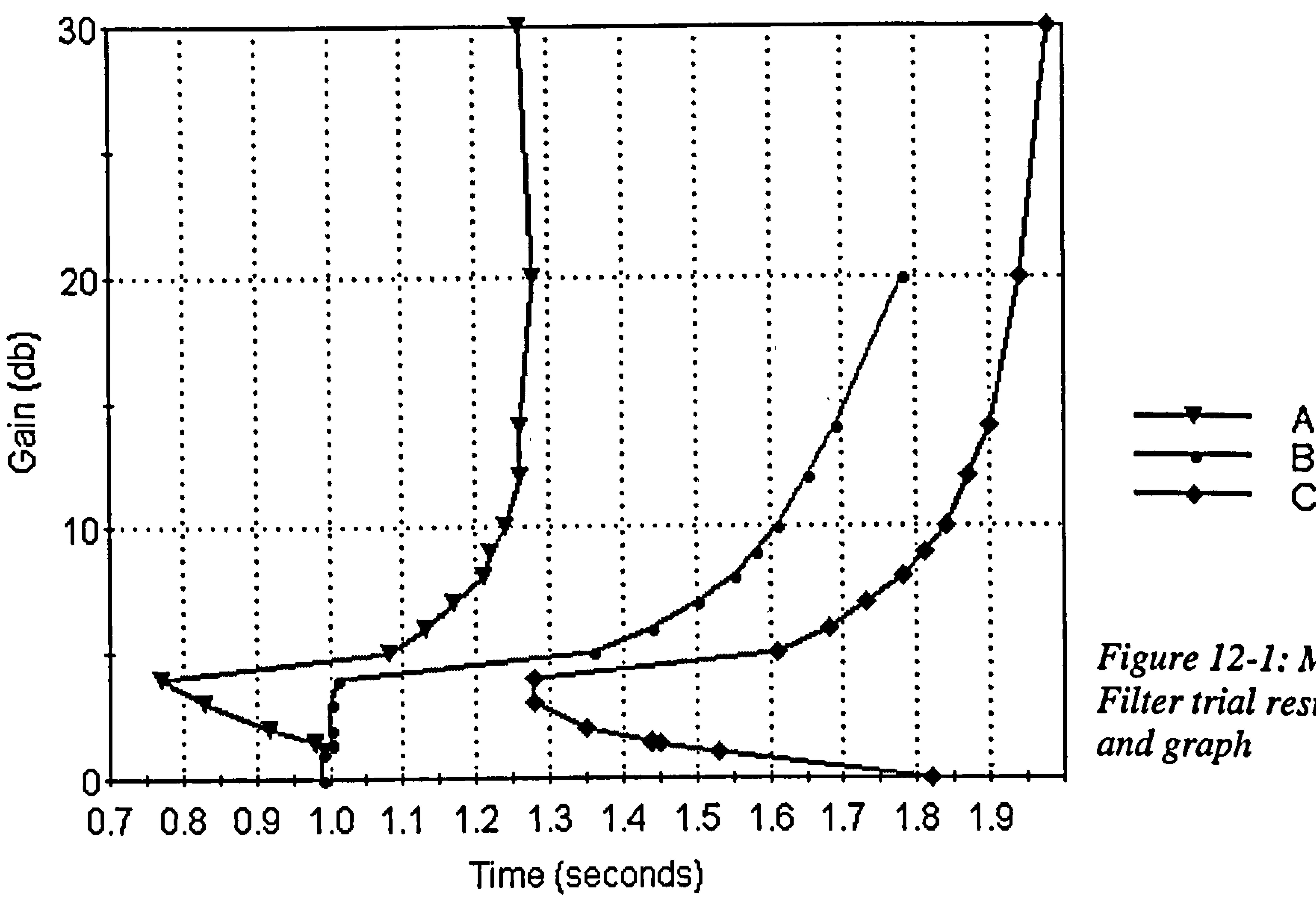


Figure 12-1: Mangle Filter trial results and graph

12.2 EVENT LIST FOR *LUMPY GRAVY, PART I*

Track Index	Time/min/sec	Description
		Spoken Word
1. The Way I See It, Barry	0:00	"The way I see it Barry..."
		Instrumental Music
2. Duodenum	0:05	Duodenum
3. Oh No	1:38	World's Greatest Sinner
	1:47	Run Home Slow Cue #2
	2:08	Oh No (vibes, bass, drums)
	3:20	Oh No (with orchestra)
	3:32	Son of Orange County
		Musique Concrète
	3:41	Electronically generated noises
4. Bit of Nostalgia	3:43	"A bit of nostalgia"
	3:45	Fragment of Hurricane by Conrad and the Hurricane Strings
	3:47	Electronically generated noises + "Kitty"
	3:55	Piano Chord
	3:56	Repeat of 3:55
		Spoken Word
	3:58	"I'm Advocating dark clothes..."
5. It's from Kansas	5:16	"It's from Kansas
		Instrumental Music
	5:17	Dixieland/Traditional Jazz
		Musique Concrète
	5:45	Percussion (tape speed varied throughout)
6. Bored Out 90 Over	5:47	"Bored out 90 over..."
	5:49	Electronic squeaks, percussion crashes and (random?) piano (tape speed varied throughout)
7. Almost Chinese	6:16	Almost Chinese
	6:18	"Almost Chinese, huh?"
	6:20	Eating sound (through delay effect)
	6:22	Snork
	6:23	"Because I was making..." (tape speed varied throughout)
	6:24	Snork
	6:25	"2.71 an hour" (tape speed varied throughout)
	6:26	Almost Chinese again, this time extended
	6:35	Snorks, coughs, glockenspiel (sped up)
	6:40	Snork
8. Switching Girls	6:41	"I keep switching girls..."
	6:52	Orchestral music (sped up)
	6:55	Single piano note (high C-sharp)
		Instrumental Music
	6:56	Drum/trumpet fanfare (based on opening notes of Oh No)
	6:59	Drum/trumpet fanfare, left and right channels reversed (sped up)
	7:00	Variation of Oh No (sped up)
9. Oh No Again	7:10	Oh No

10. At the Gas Station	8:23	Final part of Oh No
		Spoken Word
	9:16	"I worked in a cheesy newspaper company..."
	9:23	"Louie Louie"
	9:24	"And then I worked at a printing company..."
	9:50	Background chatter fades into right channel and moves over to the left
	10:19	Drum beat in right channel
	10:32	Motorhead's voice moves from centre to right
	10:47	Drums move from right to left
		Instrumental Music
11. Another Pickup	11:04	Heavy blues on harmonica
		Musique concrète
	11:25	Snorks, coughing, glockenspiel (sped up)
	11:38	Drums and piano (sped up)
	11:56	Two snorks and a cough
		Instrumental Music
12. I Don't Know If I Can Go Through This Again	11:57	Orchestral Music
	13:02	"Oh Man, I don't know if I can go through with this again"
	13:07	Orchestral Music
	13:44	Orchestral Music (sped up)
	14:05	Electronically generated noises (tape speed varied throughout)
	14:17	Orchestral Music

- Left-hand column indicates track index (as printed on Lumpy Gravy sleeve)
- Right-hand column indicates sections of instrumental music*, musique concrète and spoken word, and identifiable edit points within.
- Track titles are underlined
- Tape speeds are normal unless otherwise stated
- Spoken word sections are indicated with quotation marks
- Spider, Motorhead, Gilly and John are the names of characters
- Snork=pig-like sound

*The sections of instrumental music make use of pitches, harmonies, rhythms and durations in a traditional way. Although they are not as densely edited or abstract as the sections of musique concrète, they use some of the associated techniques, such as variations in tape speed.

12.3 EVIL'S VEGETARIAN CHILLI RECIPE

Without the nutritional goodness provided by the following recipe[1] this PhD would not have been possible:

1 cup of red split lentils
1.5 tins of chopped tomatoes
1 tin of chickpeas or 1 diced butternut squash
1 tin of kidney beans
1 large cooking onion – finely chopped
1 big red pepper – not so finely chopped
4 to 6 crushed cloves of garlic
2-3 hot green chillies – coarsely chopped.
1 heaped teaspoon of ground cumin seeds
1 teaspoon of yellow mustard seeds
Chilli powder (to taste)
1 teaspoon of cayenne pepper
1 teaspoon of cocoa powder
1 teaspoon of oregano
1 bay leaf
20ml of good red wine vinegar
Butter or vegetable oil
500ml of water
1.5 teaspoons of salt
Ground black pepper
Sour cream or grated cheese

Serves 4-5 people or 1 person for 4-5 days.

First, prepare the ingredients. Chop the onion, red pepper and chillies, and crush the garlic. Pour the cumin seeds into a large dry saucepan and place over a hotplate on medium setting. When they start to steam add the mustard seeds. When the seeds begin to pop, transfer them from the saucepan into a pestle and mortar, and grind into a fine power.

Place the saucepan back on the hotplate on a high setting and add a knob of butter (or some vegetable oil). When all the butter has melted, add the chopped onion and fry for 2 - 3 minutes. Then, reduce the heat and add the garlic and the chillies. Cook for about 10 minutes or until the onions begin to caramelise, then add the salt, ground black pepper, cumin/mustard power, cayenne pepper and cocoa powder. Cook for a further 1- 2 minutes.

To this, add the tinned tomatoes, vinegar, lentils, bay leaf, chopped red pepper, butternut squash (if using) and about 500ml of boiling water from the kettle. Cover and simmer for 10 minutes, then add the chickpeas, kidney beans and chilli powder. Simmer for a further 10 – 15 minutes. At the end of this process, remove the saucepan from the hotplate and let it stand for about 5 minutes.

This meal (which can be eaten on a daily basis for up to five years without becoming boring) is best served with rice. If you've just been paid, grate some cheese over the top or add a blob of sour cream. Also, have a mug of beer close by in case it's too hot chilli-wise. Choice of listening material: *Permanent Damage* by the GTO's.

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[1] Owing to the financial restrictions faced by its creator whilst conducting this PhD, this recipe is meat free; however, vegetarians and vegans should be advised that adding meat to any savoury dish enhances the texture and flavour of the food unquestionably.

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