Intervention and Appropriation

Studies in the Aesthetics of the Homemade in Real-Time Electroacoustic Composition

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Abstract

The works presented here consist of modified electronic devices, self-programmed computer code and a contextualising text which examines the technological, cultural and aesthetic situation of the pieces. An audio CD, listings of the computer code employed and photographic documentation of the objects produced are included with this document. The aim of the investigation is to consider alternative methods of engagement with technology which incorporate accident, error and exploration along with more considered, design-led approaches. To this end the work is examined in relation to sets of contrasting and related concepts – 'composition / improvisation', 'design / modification', 'digital / mechanical', 'precision / chance', 'expertise / inexpertise' – to demonstrate ways in which these notions can inform creative activity. The work of a wide range of artists and theorists whose practices or interests are deemed to lie within similar territory are discussed and compared, and ways in which alternative, personal creative responses to technology can be formulated are suggested.

Contents

Introduction

The 'works' investigated in this document consist of recordings of music made using modified consumer electronic devices and self-programmed software, performed by human and electronic actors. This text is accompanied by an audio CD containing these recordings, an appendix listing the code of the programs and photographic documentation of the sculptural musical devices. As the works deal intrinsically with technologies and our various relationships with them in a musical fashion, the technical, cultural and aesthetic aspects of the objects, recordings and programs will be examined along with those of other selected artists and theorists deemed to be dealing with similar issues and materials. This will attempt to contextualise the works in terms of their historical and theoretical situation as well as discussing a wide range of otherwise apparently unconnected artists and concepts.

The proceeding sections will examine these works in the contexts of their relation to sets of concepts often viewed as being dialectically opposed or asymetrically privileged. These notions will be unpacked and discussed in terms of my relations with them during the processes of creation and the subsequent situation of the objects and sounds produced. In this way it is hoped that a meaningful contextualisation of the works can be gained and alternative possibilities for creatively engaging with technology can be put forward.

Chapter 1 discusses various notions of what constitutes the activities of **'composition'** and **'improvisation'** and how these apply to the way I perceive my working method. Sociological implications and issues of relative 'value' are examined, along with specific questions relating to the influence various technologies might exert on these activities.

Chapter 2 examines the practical areas of **'design'** and of **'modification'**, with particular reference to the creative modification of electronic equipment. The cultural and conceptual impacts of such practices are discussed in addition to issues concerning performance using these devices and specific approaches to utilising technology.

Chapter 3 contrasts **'digital'** and **'mechanical'** systems, their perceived qualities and possible ways in which they can be combined in a musical framework. The work and methodology of several other practitioners, both musical and otherwise, involved in this field are examined and compared in relation to my own.

Chapter 4 deals with **'precision'** and **'chance'** and their roles in music-making. Historical applications of chance factors pertaining to musical activity are discussed and wider issues of coincidence and contiguity are addressed.

Chapter 5 examines **'expertise'** and **'inexpertise'**, taking a deliberately provocative stance to illustrate ways in which inexpertise and lack of knowledge can be important, useful creative factors. Related topics such as 'amateurishness', modern-day folk art and banal technologies are also assessed to aid the contextualisation of the presented pieces.

The sections are deliberately related and overlap in their subject matter to varying degrees to form a multi-faceted examination of the elements involved in the creation of these works. The pieces will be considered from different perspectives in each chapter, illustrating how they fit within, without or between these sets of concepts.

For the sake of convention in the following text, the titles of works which appear on the accompanying CD will be presented in **bold** type followed by their respective track number in parentheses e.g. **tango** (10). Titles of works by other authors / artists will appear in *italics* and the names of software objects used in either *Supercollider* or *MAX/MSP* patches will be placed in [Square brackets]. The code for these patches is listed in Appendix 1, while photographic documentation of the devices discussed and other illustrative images appear in Appendix 2.

Composition / Improvisation

The specific working methods involved in the act of composition will be as many and varied as the number of compositions in existence, but the overall outcome is broadly the same: a set of pre-determined instructions given to human(s) or machine(s) to realise[1]. The composer who notates a symphony, punches holes in a pianola roll, produces rule-based cue-cards, types an algorithm or writes digital sonic information onto a CD-R is involved in the creation of coded information to be interpreted and decoded later.

The fact that composition results in a product which is, to varying degrees, fixed and predetermined, often coming about from multiple listenings, rejected alternative directions and correcting of 'errors', permits the creation of structures, sonic relationships and developments which would be impossible to achieve purely by improvisation. By the same token the more permanent a composition is, the more fixed its nature, the faster it becomes 'known', familiar, unsurprising.

Improvised music, in particular 'free' or 'non-idiomatic' improvisation, stands at the opposite end of the spectrum. Where composed music has predetermined rules, structures and relationships, in improvisation these factors are all decided during the performance as the music develops. And just as the studied, contemplative nature of composition makes available certain types of structure and forms, so the enforced spontaneity and focus which comes with the specificity of improvisatory performance can bring about results impossible under other circumstances.

In many accounts of musical activity composition is contrasted to improvisation in terms of the 'seriousness' of the results which can be produced by each method. Luminaries such as Theodor Adorno[2], Pierre Boulez[3] and Arnold Schoenberg[4] have put forward cases which privilege the working out of complex ideas outside of the time-frame of the actual performance event itself, whereas writers including Alan Durant[5], Edie Prévost[6] and Ricardo Arias[7] contest that the unpredictable, ephemeral nature of improvisation can "force the musician to performance responses hitherto unthought of"[8] and critique dominant cultural values.

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[1] This definition may be extended to include instructions given to animals (see the account of the Thai elephant orchestra in Soldier, D. (2002) p.57).
[2] Adorno, T. (1936/1989).
[3] Boulez, P. (1976). Quoted in Durrant (1989).
[4] Schoenberg, H. (1967).
[5] Durant, A. (1989).
[6] Prévost, E. (1995).
[7] Arias, R. (2002).

[8] Prévost, E. (1995).

I should probably at this stage state that I do not consider myself to be either a composer or an improviser, rather that at various times I involve myself in predominantly musical activities which include elements that can be viewed as 'compositional' or 'improvisational'. While the above accounts relate to instrumental rather than specifically electronic music and the potential inherent differences therein, the general theories and positions are still commonly accepted[9]. As my work explores particular elements of human-machine relationships and various objects are recontextualised and re-purposed for the (semi-) autonomous production of musical material, certain devices come to have their own voices and influence in terms of both pre-determining and spontaneously generating material and structures. By experimenting with these new contexts and configurations for the interplay between human and electronic actors I have tried, returning to Prévost's assertion, to force both 'to performance responses hitherto unthought of'.

As with all ideals, these definitions are rarely as clear-cut and well-defined in practice. A composition may incorporate recordings (mechanical, digital or notated) of improvised material or require the interpreting musicians to improvise to varying degrees during its performance. Alternatively, an improvised performance may make use of a pre-determined structure or set of relationships within which the performers agree to operate, or an improviser may decide to play (or re-play) a fragment of pre-composed music during the course of the performance. In the work presented here, various creative activities can be analysed in relation to their exhibition of compositional or improvisational qualities, as well as the overlaps and dependencies between these two categories.

This blurry distinction between composition and improvisation is evident in **duet** (1), the first piece in which I experimented with live electronic performance, which initially can be viewed as consisting of two parts - one 'composed' (the software) and one 'improvised' (the live performer). Whilst composing purely fixed electronic ('tape') music I had gravitated toward processing software which allowed effect parameters to be manipulated in real-time and 'played' using the mouse or midi controllers. Utilities such as *GRM Tools* and Arboretum's *Hyperprism* engine permitted the user to audition the processing of the sound before it was permanently applied and alter the parameters whilst listening to the changes, whereas *SoundHack*, *Cecilia* and *Metasynth* provided visual facilities in the form of tables, graphs and sonograms, for varying the DSP processing over time.

The ability to control and play parameters of a sound over time immediately appealed to me on an aesthetic level as I found even very subtle variations held my interest and attention more than determining static settings, and the movement and change that became inscribed in the sound implied a greater sense of the human and the bodily. The end result exhibited attributes which could be conceived of as having been 'made' rather than simply coming into existence.

These two elements (predetermined control tables and real-time parameter change) form the basis of **duet** (1) for a live (conventional) performer who sends an audio

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[9] For a detailed examination of specific concerns relating to electroacoustic improvisation, see Bowers, J. (2003).

signal to a *Supercollider*[10] patch where it is manipulated in real-time. Before the piece is played several characteristics relating to the instance of performance are determined in the patch. There are two processes involved in the software half of the duet – a live sampler / loop player, and a delay-line based granular synthesis engine, each with its own parameters. Initially the overall length of the piece needs to be decided[11] to set the reading speed for a series of tables associated with each of the main elements influencing how the incoming sound is dealt with. Aspects such as grain size, density and amplitude, along with pitch, pitch dispersion and time dispersion are common to most granular synthesisers and were included here for the delay-line playback. The loop player has independent pitch and length controls, and there is also a table which determines the likelihood of new material being recorded into the sample buffer. The final table affects the amount of random information sent to the 'stable' parameters of the delay-line resulting in reverse playback and extremes of pitch and duration.

The software therefore acts as a 'second performer', transforming the sounds produced by the live instrumentalist and suggesting possibilities for the development of the piece. By initiating these factors before the performance it is possible to establish the overall shape of the computer processing (the actual sonic outcome being reliant on input from the performer) as the piece progresses while still retaining elements of unpredictability and surprise for both the performer and the audience.

The recording presented here consists of an improvised electric guitar and distortion pedal part being fed into the **duet** (1) patch. As there is no obvious physical correlation between the performer and the electronics in this piece, I attempted to explicate the mechanics of the relationship by playing a fragment of the 'dueling banjos' theme from the film *Deliverance* – a reference I could be fairly sure would be familiar to the audience and one which I felt illustrated the processes (delay, sample playback) in a succinct and light-hearted way. Already elements of both improvisation and composition are evident, where the 'score' (or 'scores') in this case is comprised of streams of parameter values stored in tables and read sequentially at the same time as the performer improvises and the software extemporises on the material. In this particular instance the distinctions are clouded further as I am at once the improviser, composer and creator of the patch, and spent a considerable amount of time testing and refining the code, a process which also involved feeding audio into the software to judge the results.

This development process will naturally have impacted on the manner in which I improvised when performing the piece, as well as my playing style while testing the patch having reciprocally affected the way in which it developed. This dual relationship clouds the issue of what can be called 'composition' and what 'improvisation' even further, as the nature of what is permitted to be composed in this case (initially the coding of the patch itself, and later the parameter tables) has been influenced by prior improvisation, while my improvisatory activity during the

[10] http://www.audiosynth.com

[11] My preference has always been for conciseness in music, and while this parameter was actually essential for the patch to work – it is impossible to read through a table without setting a speed at which to do so – I also hoped that this would serve to curtail any over-indulgence which could easily arise from the improviser.

performance is coloured by the experience of assembling and troubleshooting the patch. While testing and 'rehearsing' the piece I therefore discovered a number of techniques which I decided 'worked well' aesthetically with the processes involved, and tailored the patch to produce suggestive material which suited my style of playing.

CD err (2) is in some ways one of the most 'composed' pieces presented here, existing as it does only as a recording on compact disc. This piece was created in 2001 during a residency at the *Institut International de Musique Electroacoustique* studios in Bourges, France, and was commissioned to be played at the festival organised by the institution that year. The sound sources for the piece are derived largely from two commercial CDs I brought with me to listen to during my stay – *Space Age Bachelor Pad Music*, a collection of recordings by Juan Garcia Esquivel, and *Live! At Disobey* by MC Hellshit and DJ Carhouse. After extracting small, mainly percussive, sections from these recordings I wrote simple *MAX/MSP* [12]patches to play semi-random collections of the samples, automatically layering and sequencing multiple fragments to create coincidental new material. These sequences were then edited into smaller sections, burnt to CD-R and replayed on a modified CD walkman, which I used to intervene in the intended playback behaviour, producing skips, stutters and distortions of the recordings as well as unexpected circuit and motor noise from the CD player. These improvisations were then themselves re-edited, re-ordered and built on in *Pro-Tools*.

This exists as a 'composition', therefore, created from the assemblage and editing of 'improvisations' by humans and machines – the autonomous *MAX/MSP* patches and my interactions with the CD player. The source recordings for these improvisations, however, already come with their own issues to muddy the waters even further. The fragments from *Space-Age Bachelor Pad Music* employed in the piece came from recordings of arrangements Esquivel had made of other people's compositions, while the MC Hellshit and DJ Carhouse CD is a document of live improvisations the duo had performed, with DJ Hellshit manipulating, scratching and replaying other commercial vinyl recordings.

What could initially be conceived of as a fixed, easily understood 'composition', the sole responsibility of one individual, when examined more closely becomes an arrangement of recordings of improvisations incorporating arrangements and other improvisations utilising recordings.

The modified CD player employed in **CD err** (2) is also used in **boogie woogie** (4), a recording of a performance using two CD players and a *Supercollider* patch. The prepared material for each CD player is identical: a selection of very short fragments extracted from a variety of recordings featuring piano sounds, commercial and otherwise. The performer plays the devices using the standard controls – play, pause, fast forward, fast reverse – combining and sequencing the prepared sounds in real-time. The CDs themselves are also physically 'prepared', however, by arbitrarily marking the playing surface with ink and tiny pieces of sellotape to cause irregularities in playback, forcing the performer to incorporate unpredictable events into their playing strategy. While the material for each CD player is identical, one is

[12] http://www.cycling74.com

modified to play at half-speed meaning that the pitch is lower and the 'loop window' of the stutter is longer and more irregular. This gives each machine different characteristics and, in keeping with the 'piano' theme, the regular speed CD player is played with the right hand, while the lower pitched material is controlled with the left.

The *Supercollider* patch is also pre-loaded with keyboard sounds, this time recordings of a circuit-bent Casio SK-5. The rewired keyboard can be forced into a state of operation where it spews out streams of seemingly random sounds, often recognisable as distorted variations of its inbuilt voices, other times more akin to digital noise. These sounds were edited into smaller sections and, depending upon their qualities, arranged into two categories, 'fast' and 'slow'.

The patch exists as a way of 'crossfading' between the live, manipulated CD playback of the piano recordings and the Casio SK-5 soundfiles. The audio output of the CD players is fed into the patch which uses an amplitude following object, [Amplitude], to listen out for attacks, and, upon their detection, triggers the transition if a certain probability is met. Once this occurs, a soundfile is chosen at random and the 'crossfade' procedure takes place. This is based on delay-line granulation of the two sounds (the live input and the recorded soundfile), with the live sound being increasingly time-stretched while the grain density is simultaneously reduced. As the sound breaks down, grains begin to be introduced from the Casio soundfile rather than the live sound, until the sources have switched completely. At the same time, the time-stretching is reversed and the grain density increased until normal playback speed is reached and the soundfile is playing unaltered. This procedure plays out over a randomly determined time scale each time it is triggered, and the detection of a subsequent attack has a chance of halting the transition prematurely.

While the material the performer is permitted to work with has been pre-composed and fixed, and is derived from a variety of recordings, its actual re-organisation and structuring is dependent on the interaction of a variety of forces. The human improviser exerts a direct influence on the playback of the CD material, either by actively intervening in the process using the CD player controls, or allowing it to continue unaltered. Unaltered by direct human control in this case, as the physical preparation of the CD itself also influences the manner in which it is reproduced. The standard linear playback can be disrupted to enable the device itself to actively participate in the improvisation.

The second set of recorded material, triggered by the software, also has attributes pertaining to both compositional and improvisational activity. The soundfiles have been chosen, edited and prepared before the performance and their role in the piece is more rigid and defined, but they too have been initially derived from an improvisational collaboration between human and machine. The keyboard 'improvised' its parts – I would occasionally intervene or interject, pressing a key from time to time or altering the configuration of the wiring to see what would happen, but largely it produced sounds without the need for any outside involvement.

Similar issues regarding automata are explored in **tango** (9), a recording of a performance also using two CD players, this time incorporating a toy accordion and a modified toy 'voice changer'. The CD players are identical makes and models, and both have had the 'mute' function bypassed to allow the 'errors' to be heard. The material for the CDs is also obtained in a similar manner, the source in this case being tango music, predominantly recordings by Astor Piazolla. More preparation was done in terms of the arrangement of the recorded material than in the previous example, however, as individual gestures (a note, a chord, a glissando, a tapped rhythm) were extracted and rearranged to form new sequences. Two sets of material were produced, one for each CD player, which interlock and complement each other. One CD contains mainly staccato, rhythmic sequences, while the other features longer, more sustained notes with occasional very short rhythms or sporadic pizzicato bursts. Both CDs also contain several tracks of silence to vary the overall density of the piece.

Instead of the CD players being controlled by the human performer as in **boogie woogie** (4), in **tango** (9) the devices influence each other's operation. In performance the resulting material is replayed, rearranged and reworked by the CD players as the linear reproduction is disrupted through various connections made between the two circuit-boards. This results in a stuttering, jittery 'tango' in which the two machines are interlinked and interacting. The human performer in this ensemble improvises alongside the CD material using a child's accordion which is connected to a circuit-bent 'voice changer' toy to modify its output[13]. The electronic device performs a variety of pitch-changing and distortion functions, allowing the performer to transform the timbre and manipulate the pitch of the electronic half of the sound independently from the acoustic one while still retaining a causal relationship. The two are coupled in such a way that the performer can play the accordion in a conventional manner at the same time as manipulating the processed version of the sound.

The 'composed' material had to be continually reworked and revised as its 'performance' by the CD players offered new ideas and suggested new directions, as well as highlighting sections which didn't work aesthetically and needed to be refined. Compositional decisions were influenced by actual instances of their possible realisation, and subsequent improvisations have been informed by this process. Once again, precomposed works are dissected and fragmented, only to be reworked and incorporated into a new performance – the actual medium of reproduction determining the structure.

Acoustic and electronic instruments are combined again in the piece **rickety-tick** (5) for modified Roland sound module, child's toy piano and *Supercollider* patch. Here the toy piano is prepared in a similar manner to John Cage's prepared pianos and connected to the sound module, triggering certain effects and bursts of noise when particular keys are pressed. These range from regular looping clicks and pops to slabs of feedback which can be sculpted or steered in desired directions with varying degrees of reliability. The two sound-producing mechanisms (one acoustic, one electronic) are inextricably linked, and it is impossible to produce certain sounds from the toy-piano without also affecting the output of the sound module[14].

As a 'hybrid' instrument, this necessitates a different approach to improvisation than the accordion mentioned above. Both result in the production of acoustic and

[13] Fig. 1.

[14] It is, however, possible to affect the sound module without producing any acoustic sound by pressing the key very softly.

electronic sounds, but whereas the accordion's output consists of it's conventional sound combined with a processed version, in this case the relationship is more complex. The electronics produce sounds which can sustain long after their acoustic counterparts have died away or which can loop indefinitely. Unlike in **tango** (9), the acoustic and electronic sounds share any similarities purely by accident, either timbral, pitched or durational. The only factors thay have in common are the method and timing of their production – when the toy piano produces a sound, a change takes place in the output of the sound module - so an artificial connection is made between a certain acoustic phenomenon and a particular type of electronic sound generation or developmental behaviour.

In this piece there is a further software element which adds a compositional dimension to the performer's improvisation. Two pre-recorded soundfiles of recordings of instructional tap-dancing exercises are subjected to a variety of beat-slicing and recursive cutting algorithms intended for the automatic generation of breakbeats for drum n bass tracks as well as being filtered and pitch-shifted. The software autonomously cuts between silence, unaltered playback of the files and real-time beat-slicing, filtering and pitch-shifting, resulting in varying degrees of rhythmic regularity. Different combinations of the processes produce material ranging from absolutely regular and recognisable tap routines to granulated, arhythmic textures.

In addition to reworking this prepared material the software also takes the mixed acoustic and electronic results of the performer's improvisation and uses several processes to arbitrate differing relationships between the various elements of the piece. Again, an amplitude follower object, [Amplitude], is used to detect attacks above a certain threshold in the dynamics of the improvised toy piano part, and this information is used to randomly allocate simple DSP effects to the sound. Two delay-line based effects, chorus and echo, with random LFO control of their parameters are available to assign to the input, and each attack either enables or bypasses the effects independently. The sound module's output is largely generated from circuit-noise feedback, which often produces these kinds of effects, and so applying these processes to the acoustic sound can to a certain extent bridge the gap between the two sources.

The input is also pitch-tracked using [Pitch], and the information this produces is used to determine a central frequency for the band-pass filtering of the soundfiles. While the accuracy of the pitch-following is often less than unerring (especially when polyphonic material is fed into an algorithm designed to accept monophonic input), this provides another structural link between the prepared material and the improvised.

Additionally, the patch incorporates a recordable buffer, the exact length of one of the tap dance soundfiles, into which the improvised material is fed. Rather than recording continually, however, the patch is designed to randomly store chunks of the input in a linear manner, playing back the buffer in a loop as it does so. This produces a steadily mutating loop which, due to its length being identical to the rhythmic soundfiles and therefore the overall 'tempo' of the piece, is perceived as being 'in time' with the tap dance. To destabilise this contiguity, a further process takes place as the loop is played. There are, in fact, two instances of the buffer which are replayed – one 'dry', the other a 'wet' reverbed version, the parameters for the effect also controlled by random LFOs. When played simultaneously, this is equivalent to having a single soundfile running through a reverb process, but the two loops can be independently time-stretched or compressed, with the patch continually making slight variations to the two speeds, constantly shifting them in and out of sync.

In addition to the read-speed of the buffers, the patch also keeps track of the 'absolute' loop speed, which is consistent with the tempo of the tap-dance soundfiles and runs through the whole patch. As the buffers are stretched out of time with each other, becoming more and more unrelated, it is possible to trigger a 're-combination' of the streams, where they gradually move closer to 'normal' speed, eventually both reaching their goal at the start of the next 'absolute' loop, and resuming playback from the start of the buffer. This process enables original material to be perceived as either a slightly reverbed single entity, multiple, changing streams of sound derived from the same source, or as the transition between these states. The performer can trigger these events by pressing pre-assigned keys on the computer keyboard, and the patch also initiates these routines at random points throughout the piece.

With this system, it is possible to explore different relationships between the elements involved - the network of connections allowing for varying degrees of unity and divergence between the pre-determined and spontaneously generated material. This continuum is navigated jointly by the actions of the human performer, the unpredictable results of the re-wired sound module, and the rhythmic reworkings of material of the software – all inter-connected and inter-reliant. The streams of improvised, aleatoric and predetermined material and processes can be forced together to give the impression of a single, relatively cohesive sonic entity, or the layers can be pulled apart and diffused, undoing the constructed relationships.

A similar approach also underlies the piece **hawaiian** (6), where again the structuring and realisation of layers of pre-composed material and relationships varies with each instance of 'performance', but this time in the context of an autonomous system. The forces involved are a mechanical, self-playing, single-string 'slide guitar', a modified CD player, and a *Supercollider* patch – each influencing the behaviour of the others. The CD material in this piece can be said to be more 'composed' in a conventional sense than in previous examples, as it is derived from recordings I made of a toy guitar being played with a metal slide, coupled with woodblock samples, later edited and arranged in *Pro-Tools*. The position of the CD player's laser 'needle' also determines the position of the slide connected to the mechanical guitar, so as the playback point changes, so does the pitch of the acoustic sound. The guitar is played by a motorised plucking mechanism powered by the USB port of the computer running the *Supercollider* patch and is also influenced by the motor activity of the CD player. The patch pitch-tracks the CD player and guitar parts independently using two [Pitch] objects, and uses their frequency relationship to synthesise a third voice based on a set of possibilities dependent on the result.

The recorded material is constructed and arranged to complement the type of sounds produced by the mechanical guitar - which it also plays a part in shaping - and the software helps to further glue these components together. The tracks on the CD needed to be considered in terms of their length, frequency content, and position on the CD in order to exert the 'right kind' of influence on the mechanical instrument – i.e. that which I found to encourage aesthetically pleasing results. In this case, I was aiming for a loose coherence in terms of pitch relationships, density of activity or timing of events, which had to be 'composed' by trial and error testing and revision depending on the behaviour of the elements which were out of my control. Possibilities for the shifting and disruption of these layers, however, are once again built in to the component parts themselves, to allow for moments of pre-arranged cohesion to break apart and be developed in different directions. As in **boogie woogie** (4) the CD has been physically prepared[15] in places to interrupt the standard linear playback of material. This also affects the behaviour of the mechanical guitar, both of which impact on the output of the computer, which in turn influences the two other devices.

In terms of 'performance' there is no human intervention in this piece, other than the starting and stopping of the process, as all the necessary connections, relationships and materials have been pre-arranged. In some respects, then, this is analogous to pure algorithmic composition, where the 'composition' exists as an expression, realised when it is set in motion. This 'algorithm', however, consists of multiple interconnected devices influencing each other's activity, pre-composed musical material which is reworked and restructured during the piece, and physical, mechanical sound producing objects which 'improvise' and react to the other elements. In this way it can be viewed more as a 'circuit' or ensemble of reactive and influencing agents, producing an outcome which is different in each instance of performance, yet retaining certain characteristic sounds and relationships integral to its identity.

The piece **blues** (3) also makes use of originally independent electronic devices coupled by new connections made between the two circuit-boards. The pieces of equipment in this instance are a Yamaha VSS-220 keyboard and a 'barcode battler' toy, which reads commercial barcodes fed into it and uses their information to provide parameters for the playing of a game. The data from the scanner is diverted away from its original course and instead is fed into particular points on the circuit-board of the Yamaha keyboard. The specific connections can be arranged in a variety of ways using a small patch bay built into the slot where the barcode reader display was originally housed. These new configurations allows the keyboard to be 'played' by swiping barcodes (or indeed any high-contrast image) through the reader, producing aleatoric streams of sound depending on the nature of the coded information.

The 'score' for this piece, therefore, consists of twelve 'barcodes' on individual cards which are fed into the scanner in any order the user wishes. These are comprised of a number of visual 'codes' pertaining to music in various ways – standard barcodes (from the box of the barcode scanner, a CD sleeve), a bar of western notated music, tablature etc. In addition to these codes, six of the cards have diagrams drawn on them which indicate a change in the configuration of the connections of the patch bay, and therefore a change in the functions of the signals emitted by the scanner. As the instrument is played by running the cards through the reader, the performer has control over which order the cards are chosen in, the speed of the reading, and also the direction – each of which affects the signals sent to the keyboard and the sound which is produced.

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[15] Fig. 2.

A further software element is also incorporated into this system – a simple *MAX/MSP* patch which plays on the convention of the 'twelve bar blues' harmonic progression. Each card passed through the scanner triggers a synthesised tone corresponding to the respective chord in the progression, which lasts for as long as the card is being read. The hybrid barcode/keyboard instrument communicates with the software through a hacked USB mouse which activates the mouse button when the reader is in action. The *MAX/MSP* patch detects the 'button down' state of the mouse using the [Mousestate] object (there is currently no equivalent in *Supercollider*) and cycles through the respective frequencies of the progression. This adds a conventional, familiar background for the unpredictable outbursts of the keyboard to work against, grounding the spontaneous improvised material in an absolutely rigid harmonic framework. Whilst working on the electronic modification of the devices, the keyboard's output would often come to rest on the same consistent pitch under certain configurations, and this regularity was used to determine the 'tonic' of the underlying harmonic progression. This emergent 'style' of 'improvised' material generated by the devices therefore informed the decision-making process regarding the composition of the fixed elements in the piece.

This paradigm of 'keyboard' control is explored to a much greater extent in **jazz** (7 + 8), a recording of an improvisation performed solely on a Yamaha Portasound PSS-380. The instrument is played inverted, with the keys resting on the performer's lap and the underside casing removed to expose the circuit-board inside. A length of insulated wire, stripped at both ends, is then used to make 'semi-arbitrary' temporary short-circuits directly between the legs of the chips. This method inherently causes the results of the performer's actions to be, to varying degrees, unpredictable. The same action may, depending on the state which the device is in, cause a single note, a chord, a short pattern or a longer sequence to be played, thus forcing the user to guide and influence the material – an approach similar to that given in accounts of Raymond Scott's *Electronium*[16].

The production of an individual note or chord from a single action can be seen to be in keeping with a traditional model of instrumental improvisation, but when the circuit generates an autonomous stream of material, the issue of responsibility becomes (even) less clear cut. As with a conventional instrument, the pitch, timbre and duration of the notes produced are affected by both the performer and the construction of the instrument, but the inclusion of data relating to the preset rhythms and auto-accompaniments which can be triggered, re-routed and mis-directed adds another layer of pre-composed potential material. The original responsibility for the creation of this musical material lies with the engineers at Yamaha, but in performance this fixed, pre-determined information is accessed and distributed in an

[16] "no –one has successfully described the Electronium. Scott once remarked that 'the Electronium is not played, it is guided'. The basic idea underlying it was that the composer could interact with the instrument to create music – in a collaboration of sorts. One set it in motion and it took on decisions of its own. It also used 'processes based on controlled randomness to generate rhythms, melodies, and timbres' How the Electronium would respond to the composer's guidance could not be predicted. Scott's hope was that the device, once set into motion, could produce in hours what would have normally taken days or weeks for composers to fashion on their own." (Holmes (2002), p.150).

unforeseen manner, leading to new and unpredictable combinations, mappings and corruptions of the data. Once again, pre-composed material and information is reworked in a real-time dialogue between human and machine.

The human performer's 'improvisational' activity, therefore, has less in common with that of a solo instrumentalist, and is more akin to the role of a band-leader, or cue-giver in one John Zorn's game pieces. Zorn's work has been a major influence on the way I think about music, in particular his use of stylistically recognisable musical fragments which are juxtaposed and transformed. It is in this context I conceive of the instrument – as a way of producing and sequencing these kinds of fragments in a very unpredictable, improvisatory manner, as well as being able to incorporate less familiar noises and other output.

The performer can decide, with the slightest touch of the wire to the circuit-board, the moment a change is to occur and, with familiarity, can control with varying degrees of certainty what the change will entail. Often, precisely how this change will manifest itself is completely unpredictable. However, from basic operations such as starting and stopping an event to more complex processes such as removing or altering a single voice in a polyphonic sequence or initiating a development of the material being produced, there are some connections which can be relied upon to perform the same function *most of the time*.

The final piece to be discussed here is, in many senses, wholly conventionally composed. **latin** (9) for modified inkjet printer and *Supercollider* patch consists of an entirely pre-determined 'score' which is realised in performance by the electronic devices. In this instance the score is a standard text file, stored in the computer and sent to the printer to create a hard copy of the file. The modifications to the printer are such that instead of being used to carry out its original tasks of feeding paper and moving the print head, the motors now control small percussion instruments made from pens and pencils. The result is a mechanical percussionist which follows the commands sent to it exactly and reproduces a text file as a series of rhythmic instructions.

The two main motors – paper feed and print-head position – are attached to separate mechanisms to produce different sounds, one a striking, percussive instrument, the other a guiro-like device. In this configuration the data sent to the printer becomes a set of durational information for each instrument, with horizontal space relating to the print-head motor and vertical space to the paper-feed controller. Blank areas of the page will make the motors move quickly, whilst initiating any actual printing slows them down. Effects such as rhythmic regularity can be reliably produced by repetitive text spacings, and the type of behaviour of each motor can also be estimated. Taking these factors into account it is possible to conceive of the general shape of the sonic outcome in terms of activity and density, but the actual specifics of the realisation of the data are almost impossible to predict as the percussive results are also reliant on the starting positions of the two motors. Additionally, a *Supercollider* patch triggers steel drum samples at a random pitch when the amplitude of the signal sent from a contact mic attached to the paper-feed percussion instrument rises above a certain threshold. This causes the striking action to act as a catalyst for the sample playback, adding a further unpredictable, yet structurally consistent and related pitched element to the system.

These approaches would be frowned upon by the writers mentioned at the beginning of this chapter, regardless of which side of the perceived divide they choose to place themselves. Even Prévost, who seems comparatively ambivalent on the relative merits of each activity, calling their relationship 'non-competitive', also declares them to be 'not compatible' before stating:

> "Composition and improvisation are different categories of music. Each is weakened when the principles of the other are introduced. When jazz is overly scored then it risks losing its identity as jazz no matter how good the ensuing music might be."[17]

This, to me, immediately begs the question 'so what?' Is 'bad jazz' (the music, not the record label) really necessarily better than 'good not-quite-jazz'? Does the label carry more import than the content? Sometimes it does feel as though this is held to be the case. Various times in conversation people who choose to categorise themselves as 'composers' have described being uncomfortable with, or feeling the need to marginalise, their involvement in creative activities which do not fit into their model of what a 'composer' should do.

A position which treats composition and improvisation less as polar opposites and more as related concerns is taken by the musician Fred Frith, who suggests:

> "[C]omposition and improvisation are different aspects of the same process... I think the process of creating just about anything involves combinations of rational thought, intuitive choice, ingrained memory, and desire. I could apply all of those words to both composition and improvisation. The process is different, and occupies different time frames, but other aspects are essentially similar."[18]

In a working methodolgy which is comprised of not only compositional and improvisational activities, but also those pertaining to instrument building, sculpture, programming, performance and electronics, the distinctions between the traditionally separate areas are not only faint, they are almost irrelevent. As each area overlaps and informs the others it becomes increasingly difficult to adopt a reductionist view of the processes involved in the creation of a work such as these, and I would hope that the accounts presented here help to illustrate how ideas of 'composition' and 'improvisation', in terms of determining instrumentation, particular types of behaviour and connections in different time-frames, are often as much informed by technological, visual or conceptual concerns as purely aesthetic sonic organisation. What is 'composed', in many cases, is not a fixed set of instructions or musical material - the realisation of an individually pre-imagined 'vision' - rather a system or

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[17] Prévost, E. (1995).
[18] Fehrenbach, G. (2002).

set of relationships which exhibits certain tendencies, arrived at through a combination of factors, and within which performers and electronic automata may improvise or extemporise. The spontaneous ‘improvisational’ activity is similarly not often strictly ‘free’ improvisation, but the semi-structured exploration of certain ideas and concepts during the real-time of performance, where the internal relationships are often unpicked or explicated, and played with as part of the piece itself.

Design / Modification

> "This device must accept any interference received, including interference that may cause undesired operation"[19]

I first encountered this bold statement on the underside of a Roland General MIDI sound module (used in **rickety-tick** (5)), and its deliberate misinterpretation has greatly informed my working method. To interfere with, intervene in, or modify an existing system or object is a very different activity to designing one, and the resulting product elicits a different mode of engagement than the original. At its best, a modified object, one which operates differently to the way we have come to expect, becomes simultaneously familiar and unfamiliar. It exists as something multiple, at once a reminder of its original self, a 'new' object in its own right, and a comment on itself and its position in the world.

There is an undeniable difference between the reception and perception of, for instance, John Cage's prepared piano and the invented instruments of Harry Partch, or an 'original' composition and its subsequent remix. The 'wounded' media experiments of Milan Knizak and Yasunao Tone, the appropriated electronics of the Modified Toy Orchestra and the Mutant Data Orchestra, Janek Schaeffer's 'tri-phonic' turntable with its second and third tone arm – all exploit previously unexplored possibilities inherent in hitherto culturally stable devices, and by doing so undermine this stability. Just like Marcel Duchamp's moustachioed Mona Lisa in *LHOOQ* or Yoshitomo Nara's overpainted traditional woodblock prints encapsulating the dual traditional / modern nature of contemporary Japanese society, these undertakings are so powerful not only due to the way they present inexpensive and effective musical ideas, but also because of the way in which they alter our perspectives of the objects used. By modifying the Mona Lisa, the piano, the turntable, the CD player, their reified, accepted status is challenged and new creative relationships are opened up. The 'untouchable' position of these objects and the 'warranty void', 'no user serviceable parts inside' presentation of consumer electronics are brought into question and shown to be as arbitrary and artificially constructed as any other relationship. The pieces presented here comprise objects and recordings which are the product of various combinations of goal-driven design and exploratory modification.

With particular reference to the modification of electronic devices, I would first like to clarify the definitions of some of the terminology which will be used. Circuit-bending is often described as 'the art of the creative short-circuit', and the basic

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[19] Part 15 of the US Federal Communications Commissions Rules (regarding radio broadcasting):
1. This device may not cause harmful interference, and
2. This device must accept any interference received, including interference that may cause undesired operation.

principle is very simple – take an existing (usually sound-producing) electronic device and make new connections on the circuit-board to produce previously unavailable results. As a term, 'circuit-bending' is accredited to Q. Reed Ghazala[20], who has been 'bending' since the 1960s after a battery-powered amp he owned accidentally shorted out, producing sounds similar to an expensive synthesiser. Whilst Ghazala is undoubtedly its greatest proponent, in actuality this practice has probably existed for much longer as

> "Lee de Forest, the inventor in 1915 of the vacuum-tube-based audion piano, wrote of the 'very weird and beautiful effects' that could be obtained by touching parts of the circuitry."[21]

Having established the fundamentals of the practice, I feel it is important to differentiate between some superficially similar activities which do not fall within the remit of this document. Firstly, circuit-bending is not the same as reverse engineering. The act of short-circuiting an electronic musical device in this way is done in an attempt to produce new and interesting results, not to understand the workings of a particular appliance. In fact, Ghazala's circuit-bending 'manifesto' and website is titled *Anti-Theory*, and he explicitly emphasises that it is not necessary to understand how a device functions in order to successfully circuit-bend it.

Secondly, amongst practitioners of circuit-bending, there are those whose goal is not to alter the nature of the device itself, but to unlock more advanced features which have been disabled by the manufacturers. Occasionally, for financial reasons, a company will use the exact same chip in different models in a line of equipment, rendering certain attributes inoperative in the cheaper, lower-end versions. Certain circuit-benders take it upon themselves to find these 'easter eggs' in order to save themselves and others money, and expand the conventional functionality of an instrument. This pursuit, noble as it may be, is also not the subject of this examination.

Thirdly, certain instances of 'creative mis-use' of electronic equipment (of which circuit-bending is a subset) are outwardly similar, but conceptually distinct. In his 'hardware-hacking' manual, for instance, Nic Collins demonstrates how a chip intended to be used for logic operations can be elegantly 'mis-used' to create an audio oscillator. Similarly, in one of the pieces presented here, **blues** (3), I employ a USB computer mouse to trigger changes in software by actions in the 'real world' by completing the 'mouse button' circuit in an unorthodox fashion. Whilst both of these examples are certainly cases of 'creative mis-use', I would be disinclined to label them as instances of 'circuit-bending'. In neither case has the object in question really been modified – Nic Collins' synthesiser feeds back on itself and its output is routed to a speaker, but the chip is not changed – simply recontextualised. Likewise, the USB mouse has no modification to its function or its output - the result, the pressing of the mouse button, is merely achieved in a slightly different manner. In addition, both of the previous examples were carried out with a pre-determined desired outcome in mind. This is, admittedly, a fine line – and one which could be viewed as

[20] http://www.anti-theory.com
[21] http://ratchetup.typepad.com/eyes/2004/04/circuit_bending.html

a difference of degree rather than of kind – but it is one which, for the purpose of this examination, I stand by in the hope of clarifying the following discussion.

I would like to put forward a definition of ‘circuit-bending’ for use here, then, as specifically relating to ‘the act of creating new, exploratory connections between components in a pre-existing circuit in order to produce previously unavailable results’, whereas the term ‘hardware hacking’ or simply ‘modification’ will be used to describe more general, largely design-led alterations. This is not intended to in any way denigrate any of the other activities mentioned above, simply to map out the specific subsets of activity which will be discussed here and clarify the distinctions made between them.

The typical methodology adhered to when circuit-bending a device essentially consists of the following steps: Firstly the casing is removed from the object, exposing the circuit-board and allowing easy access to the components. Secondly, the circuit is ‘explored’ for new connections yielding interesting results, either by ‘sniffing’ for activity *à la* Nic Collins[22] or by probing with the stripped ends of a piece of wire. These connections are then noted and later soldered to appropriate methods of control – potentiometers, switches, buttons - and the device is finally re-enclosed, either in its original casing or in an alternative housing.

It was this practice I followed (at this stage out of instinct rather than any knowledge of these guidelines) after first being motivated to explore the possibilities of circuit-bending after seeing Jonathan Impett perform Nic Collins’ *Broken Light* at a concert held at the University of East Anglia, Norwich – a piece for live instrumental performer and modified CD player. The result was similar to some of the effects I had been experimenting with using granular synthesis techniques, but with the distinct brittle, ‘slippery’ interjections which accompany skipping CD playback. I had already experimented slightly with the physical preparation of CDs, using sellotape and marker pens to obfuscate the data on the disc, forcing the error-correction circuitry to overload and cause anomalies in playback, but this proved to be inconsistently reproduced on different makes and models of CD player. Collins’ approach of modifying the *hardware* itself – the method of reproduction rather than the physical media – offered a much more attractive alternative as it could be used with any ‘input’. Additionally, an interview with Nic Collins made this modification sound disarmingly simple:

> “I reasoned that, unlike a record, the laser ‘needle’ did not pick up on pause or when moving from track 1 to 11. So I hunted around inside my player and found a signal intriguingly labeled ‘mute’. I ripped the pin off the chip, and the player hasn't shut up since.”[23]

By bypassing the signal on the circuit board of the CD player which mutes any ‘unwanted’ sounds[24], all the detritus is routed to the main output: skips, glitches, snatches of data from intermediate tracks when skipping ‘from track 1 to 11’. Whilst

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[22] Using a magnetic ‘telephone tap’ coil and a battery powered amp, areas of activity and possible interest on a circuit-board can be ‘heard’.
[23] Walters, J. (1996).
[24] Fig. 3.

trying to induce this specific behaviour, I happened across other short-circuit connections which altered the sound in unexpected ways. Various distortions, signal noises, and disruptions in the linear progression of the playback presented themselves. by noting these connections and soldering lengths of wire to the pertinent points of the circuit board, these effects could be produced at will by touching the ends of the wires together. Eventually, after much trial and error, I succeeded in reproducing Nic Collins' modification and my CD player, too, hasn't shut up since.

It then became apparent that I needed to devise an interface which would allow me to make multiple connections quickly and easily. After nearly buying a numeric keypad and a box to house it, I remembered that the second-hand shop from which I had bought the CD player had a large supply of unwanted TV remote controls (essentially a numeric keypad handily pre-housed in a box) which were not only cheaper than my initial solution and required no assembly, but also complemented the CD player both aesthetically and in terms of the overall concept of repurposing and modification.

This CD player formed the basis of a piece I composed at the studios of the *IMEB* in Bourges, France, after being awarded a residency in their festival in 1999. In **CD err** (2) (the name alluding to the French pronunciation of CD-R as well as the 'malfunctioning' technology involved) I attempted to incorporate sounds and structures characteristic of the actual reproduction medium (CD) into a music still described as 'tape-music', despite CD-R replacing DAT as the storage medium of choice[25]. The basic techniques of sound transformation available in software applications such as *Peak*, *Pro-Tools* etc – phasing, flanging, delay, reversing, changing playback speed - are derived from processes made possible by the manipulation of magnetic audio tape. By modifying this playback device and allowing it to function more as an instrument, it became possible to utilise features inherent to the medium in the music itself.

I have since returned to this CD player several times for the realisation of other pieces, and it has proved to be a versatile source for possibilities of control as well as for sound production. In **hawaiian** (6), the signals intended to control the position of the sled which houses the laser 'needle' are also used to influence the operation of a small mechanical slide guitar. This is a case in point regarding overlapping issues of 'design' and 'modification', 'circuit-bending' and 'hardware hacking'. The CD player in this instance is not modified for purposes of control – the circuit board is not altered, no new connections are made. Instead, the signals which control the motor connected to the sled mechanism are 'syphoned off' to an identical mechanism, this time with a metal 'slide' attached rather than a laser, and which forms part of the guitar. The guitar itself is constructed primarily from the inner workings of another CD player – a radically modified object, yet one which was also carefully designed and built from a selection of parts for this specific purpose.

With **tango** (10) I wanted to create a similarly autonomous system whereby the circuit-boards of two CD walkmen are connected at various points, each one affecting the operation of the other rather than a mechanical, acoustic instrument. Unlike the motor control in **hawaiian** (6), I tried a more exploratory approach, attempting to

[25] During my stay at *IMEB*, the studio technician mentioned that their archive material was now stored on CDs rather than DAT.

connect the two CD walkmen in a sonically interesting and conceptually meaningful manner, eventually remembering that the 'mute' pin of the chip mentioned above was, in my modification, levered up from the circuit-board rather than pulled off completely, allowing it to be utilised in a different configuration and for a different purpose. The pin sends out a signal whenever the CD player is paused, moving between tracks, or when the error-correction fails, and this signal is conventionally routed to a control which stops the sound being output. The basic principle of **tango** (10) revolves around the re-routing of this signal from one CD player to the other. CD player 'A' has its mute signal routed to the Fast Forward control of CD player 'B', which in turn has its mute signal connected to the Fast Reverse control of CD player 'A'. In this configuration, the devices together create an autonomously functioning system in which the signals sent from one machine to the other not only affect operation one way, but also influence what is fed back. The CDs used in this piece contain basic building blocks of a 'tango' - short rhythmic cells, sustained notes, pizzicato chords, glissandi - which are replayed and re-ordered by the CD players, their electronic connection resulting in repeated sections, stuttering, fragmented rhythms and accelerated playback.

A human performer is also involved in **tango** (10), playing a child's accordion which is fed through a circuit-bent 'voice changer' toy. This was a novelty device which applied a variety of pitch-shifting and distortion effects to any audio sent through it, and now has expanded and altered control over its operation. Essentially, the basic function is the same – a small microphone picks up the sound produced by the accordion and feeds it through the distortion circuit. However, where the original device had a series of buttons to choose which effect is applied to the sound, in its reconfigured state it has only one 'body contact' as a control. This consists of two connections on the circuit-board extended outside the casing and attached to small strips of metal. The performer bridges the two points with their thumb, channeling the flow of electricity (too small to be even felt) through their skin and acting as a human resistor. If the performer gently varies the amount of pressure and surface area applied to these connections they can alter the pitch of the current process, whereas making and breaking contact like a switch cycles through the range of effects. This very simple modification allows for fine nuances of control as well as the previously available switching operation in a single mechanism, accessible to the performer without impacting on the conventional instrumental playing technique.

Despite the unorthodox coupling, the relationship described above is a comparatively conventional one of sound producer / modifier, of 'electric guitar' and 'effect pedal'. A more unusual hybrid instrument is employed in **rickety-tick** (5) – a combination of prepared toy piano and circuit-bent Roland General MIDI sound module[26]. The toy piano is physically prepared in a 'traditional' manner *à la* John Cage, with various nuts, bolts, springs and wire fastened to the chiming rods to give a more percussive, less sustained sound.

The sound module is circuit-bent in a manner which disregards its original reliance on MIDI data to produce sound, instead creating internal short-circuits which produce unpredictable clicks, tones, loops and feedback. Signals from the chips are routed to the onboard reverb / chorus effects, incorporating the 'sounds' of the circuit itself into

[26] Fig. 4.

the output it produces. For a time after completing these modifications I played the device simply by leaving stripped wires protruding from the casing and touching the ends together to complete the connections, but this proved unsatisfactory both in terms of sonic interest and control possibilities. Transferring the mechanism of connection to the keys of the toy piano added a further (acoustic) dimension to the sounds which could be produced as well as establishing a more involving method of interacting with and intervening in the behaviour of the two objects, as the performer's actions have consequences for two distinct yet connected sound sources.

A similar hybrid instrument concept is explored with a Yamaha VSS-220 keyboard and a 'barcode battler' game[27]. This system is in some ways a more straightforward one-way control relationship than some of the others presented, and the modification and connection of the two devices was carried out to achieve a specific objective. The overall concept – to create a device which would produce sonic material based on the information stored in barcodes – was realised through the modification of two unrelated objects. Initially the keyboard was subjected to the standard circuit-probing procedures described above to determine points of interest on the circuit-board, and these were then temporarily connected to components on the circuit-board of the barcode scanner by crocodile clips. This process continued until, by trial and error, configurations were discovered which gave suitably varied and interesting results. A set of six phono sockets was used as a small 'patch bay' and set into the space where the now redundant LCD screen for the game was positioned, allowing for easy re-configuration of the connections. An overall sense of design is evident in this relationship, yet the individual specific connections involved and the results of its operation are the outcome of trial and error modifications of the devices involved, the following of certain possible directions and rejection of others opened up by this process.

Once a device has been modified and rehoused, there is a great reluctance to re-open it. Partly, this arises from the sense of achievement and relief which come from a successful modification – the object yielded worthwhile results and didn't break – and partly from a sense of completion, the fixing of new relationships. However, the act of circuit-bending itself highlights the unstable, arbitrary notion of 'completeness'. The device was 'complete', finished, before it was modified. After opening the casing and altering its function, the device can never appear 'finished' again - there is always the possibility of other connections not yet discovered, other relationships to be formed, and this concept runs through the pieces presented here.

It was the attempted sidestepping of this re-fixing of potential made possible by the exposure of the circuit-board that became my aim when circuit-bending a Yamaha Portasound PSS-380 keyboard. The process of exploration in this case yielded different results to any other device I had previously worked with – instead of altering a process set in motion by the user in the conventional manner or producing a single tone or event, a single temporary connection between two points on the circuit-board could result in a chord, a phrase, a repeated pattern or larger-scale sequence. The preset auto-accompaniments built into the keyboard can be triggered and the data governing pitch, timbre and rhythm corrupted, misdirected and combined, producing skewed versions of the original sequences. Sometimes these are recognisable as the

[27] Fig. 5.

styles they are 'supposed' to be, sometimes not. Initially I proceeded with the customary approach of making arbitrary connections between the pins of chips on the circuit-board and noting any worthwhile results, going so far as to narrow down what I saw as the 'useful' pins and solder free-floating wires to them for future use[28]. Having completed this stage, I closed the instrument back up and tried out the new possibilities of the connections I had made. In this instance, however, this seemed insufficient, the process unfinished. Firstly, there were many more interesting signal re-mappings that I discovered than in other devices I had worked with – too many to meaningfully incorporate into a standard patch-bay / switch / potentiometer interface. I flirted with other ideas for negotiating these possibilities including gloves with metal strips running between the fingers or a series of metal rods to which the free-floating wires would be crocodile clipped, but none of these appealed or were feasible. Secondly, the same connection would rarely produce the same result twice – often the same *kind* of effect would emerge, other times something completely different or nothing at all.

As the unpredictability and number of the permutations precluded the use of a conventional interface, a different way of thinking was necessary. I decided to choose a performance method which mirrors that of the 'exploratory' stage of circuit-bending activity – the keyboard is played upturned, its lower casing removed, and a hand-held length of wire used to connect points on the circuit-board. The 'floating' wires intended for use in an abandoned interface concept still remain on the board, now acting simply as markers, analogous to frets on the neck of a guitar. In this way the (usually hidden, pre-performed) step of the process is explicated in each live performance, a real-time 'modification' of the circuit is acted out and explored, taking different directions and establishing different relationships between the components each time.

As more short-circuits are made, more instabilities are introduced into the system, and the keyboard functions more unpredictably. The 'state' in which the device is in, continually changing as the performance takes place, has an effect on the outcome of the connections made at that point in time. The front panel of the keyboard – the 'proper' controls – also start to perform new, unrelated functions. The keys play pitches they shouldn't or induce other changes in the material. In addition, once 'stable' interventions have changed their functions. During one performance, a connection I relied upon to 'reset' the keyboard to its original, unaltered state suddenly started to produce more unpredictable (and interesting) results – the instrument had changed its operation mid-concert. The familiar performance surface therefore becomes irregular, misleading, and is transformed with each new connection. The performer is forced to constantly re-examine and re-think their relationship with the object, exploring and guiding the sounds rather than exerting complete control. Almost all elements of 'design' are absent or have been discarded from this project – no new control interface has been built, the performer is not in direct command of the musical results – yet the instrument has also not actually been 'modified'. Instead the method of performance is akin to a different instrumental playing technique - one I have (semi-seriously) likened to opening the lid of a piano and playing the strings inside – a technologically mediated negotiation of the

[28] Fig. 6.

performer's intent and a real-time modification of the device through which that intent is realised.

In contrast, the modified printer employed in **latin** (9) is an almost purely design-led project, realised by the physical modification of an electronic device. Whilst artists such as *the user*[29] have employed dot-matrix printers in their work, these have been unaltered, recontextualised machines. A unique approach to printer modification is demonstrated by Paul Slocum in the form of his re-configured Dot-Matrix synth[30], in which the EPROM of the printer has been re-written to enable the user to produce specific pitches from the operation of the motors, firing-pins and error buzzer.

These examples illustrate different approaches to the themes of 'creative abuse' and modification by placing the printer in a musical context, but all utilise sounds inherent to the device itself. In this piece I wanted to utilise the structures which could be derived from the data received by the printer, but not the sounds which usually accompany them. The rhythmic element is an intrinsic aspect of the conventional operation of the device, normally overlooked (or 'overlistened'), becoming silent, an unnecessary byproduct of the primary function. The modification in this instance simply enhances this aspect, drawing attention to the rhythms and patterns created by the operation of the device by introducing more overtly 'musical' features. I also decided that as the original device was intended to perform a visual function, the modified object should also have a strong visual element. To these ends my modification of the printer took the form of a physical reconfiguration of the internal components of the device rather than a remapping of signals on the circuit-board.

The two primary motors integral to the printing process – the paper-feed motor and the print-head position motor – are removed from their original positions and functions and re-housed outside the casing in order to control mechanical percussion instruments. These again combine elements of both design and modification as their construction is based around stationery items incorporated into motorised percussion mechanisms. The conceptual reasoning behind utilising pens and pencils as elements in this piece should be self-evident, and it also enhances the visual impact of the object.

The modification of hardware objects in these ways is a very revealing experience. There is a great feeling of liberation that comes with the realisation that it is possible to open up an electronic device, modify the circuit or other components, and not only will it not immediately burst into flames, sometimes it produces extraordinary, unpredictable results unachievable in any other way. As a working methodology, modification can instantly create a certain type of 'newness' - "it is easier to leap from a stable premise than to invent a new one out of thin air."[31] A modified object refers to both its original and altered states, and by signifying what it 'was', it also immediately proclaims itself to be 'not that' anymore, but something different. This notion of 'defamiliarising the familiar' is a recurring one in art forms from the last hundred years or so, originating in the work of the Russian Formalists. Viktor

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[29] http://www.sat.qc.ca/the_user/dotmatrix/en/intro.html

[30] Slocum, P.

[31] Couroux, M. (2002) p.55

Shklovsky describes the process of habituation, the increasing invisibility of ubiquitous objects or actions as the apprehension of

> "…objects only as shapes with imprecise extensions; we do not see them in their entirety but rather recognise them by their main characteristics. We see the object as though it were enveloped in a sack. We know what it is by its configuration, but we see only its silhouette. The object, perceived thus in the manner of prose perception, fades and does not leave even a first impression; ultimately even the essence of what it was is forgotten… And so life is reckoned as nothing. Habitualisation devours work, clothes, furniture, one's wife, and the fear of war. 'If the whole complex lives of many people go on unconsciously, then such lives are as if they had never been.'"[32]

The technique of modification in the way presented here can "make objects 'unfamiliar', …make forms difficult"[33] by thinking of the object in terms of what it consists of, rather than - or more correctly, as well as - what it has come to mean culturally. A printer, for instance, can be conceived of as a set of computer-activated, motor-controlled mechanisms as well as being a device which translates digital information into images on paper.

The act of intervention, of modification, is ultimately one of appropriation. Altering the function of something, personalising it, is a declaration of a changing territoriality - a statement to the original manufacturers that the object no longer works 'your way', it now works 'my way'. For a large number of circuit-benders, this is an end in itself – the process of discovery and alteration, subversion and personalisation is sufficient, no more is demanded of the activity. The resulting objects exist as demonstrations of alternative possibilities, souvenirs of the journey, without the need to be utilised in recordings or even necessarily exhibited in public performances. Viewed in this way, circuit-bending, hardware hacking, modification, can be seen to reveal similar characteristics to those claimed for improvised music by Durant:

> "As something people do for themselves, too, improvisation stresses independent activity rather than passive consumption… The challenge posed by improvised music might thus be thought to have largescale political or epochal reverberations, linked to the circumstances in which music is produced, circulated and heard."[34]

These traits also find resonances in economist and historiographer Jacques Attali's writings about *Noise* (and music), where he arranges periods and methods of musical activity into four historical categories - *Listening, Sacrificing, Representing, Repeating* - and one possible emergent category – *Composing*. Despite the disparity in terminologies, the activities described above bear more than a passing resemblance to qualities expressed by Attali as being necessary for the successful transition to the phase of *Composing*:

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[32] Shklovsky, V. In Rivkin, J. and Ryan, M. eds. (2000) p.17.
[33] ibid p.18.
[34] Durant, A. (1989) p.253.

> "We are all condemned to silence – unless we create our own relation with the world and try to tie other people into the meaning we thus create. That is what composing is. Doing solely for the sake of doing…playing for one's own pleasure."[35]

This claim is consistent with Durant's suggestion above regarding free improvisation, yet Attali continues, warning that:

> "Inducing people to compose using predefined instruments cannot lead to a mode of production different from that authorised by those instruments. That is the trap."[36]

Changing those given instruments, then, personalising them and creating 'our own relation' with them could go some way towards side-stepping this trap in a realistically achievable way – it is not necessary to create non-'predefined instruments' completely from scratch. Furthermore, Attali calls for:

> "[T]he worker's reappropriation of his work. Not the recuperation of the product of his labor, but of his labor itself – labor to be enjoyed in its own right, its time experienced, rather than labor performed for the sake of using or exchanging its outcome. The goal of labor is no longer necessarily communication with an audience, usage by a consumer, even if they remain a possibility in the musical act of composition."[37]

This enjoyment of labour in and of itself is precisely the activity described above regarding the 'journey of discovery' involved in each act of circuit-bending, a personal process of the assimilation of 'noise' – after all what could be more 'noiselike' than something 'going wrong', making sounds it shouldn't make?

Applying this approach to software is a more difficult proposition – instead of being governed solely by the rules of electronics (which it is not necessary to know in order to perform such modifications), working with software introduces restraints arising from computer hardware, operating systems and user interfaces, as well as the knowledge required to be able to use or program the software. Whilst it is possible to make completely arbitrary connections between electronic components, to use one's fingers to regulate the flow of a current or to spit on the circuit-board and alter the function of a device, there are no real equivalents in the world of software.

Nevertheless, my initial approach to software programming was one of modification rather than design. When I started to explore live electronic processing, the studio computers at the University of East Anglia were equipped with *Supercollider*, a real-time musical programming language. Unlike graphical programming applications such as *MAX/MSP* or *PD*, *Supercollider* is a command-line based language and as I

[35] Attali, J. (1999) p.134
[36] ibid p 141
[37] ibid p 142

had some experience with programming in *BASIC*, the concept at least of such a language was familiar to me. The specifics, however, proved more elusive and, due to the relatively early stage of development and limited userbase of the application, the user manual for the program proved comparatively cursory and jargon-heavy for me at that time.

Despite this, there were several example patches (the term used by *Supercollider* for a program written using the application) included which demonstrated some of the sound synthesis and transformation possibilities of the software. By treating these patches as ‘found objects’, as readymades - altering numeric values, copying and pasting chunks of code from one example to another - it became possible to create modified, collage patches in a similar manner to the hardware objects. The patch employed in ‘duet’ is an example of this approach, steadily evolving from combinations and modifications of multiple examples.

As my understanding of the program grew through this process I was increasingly able to design and construct my own patches, initially in order to ‘expand’ existing sound sources by use of multiple processes and transformations (as in ‘duet’, for example), then later often using the software as a single aspect in a piece to unify more unpredictable hardware elements. In **boogie woogie** (4) for instance, the software bridges the ‘divide’ between recordings of a modified Casio SK-5 keyboard and the ‘acoustic’ piano material replayed on the CD players. The two sources are not related in terms of their sonic characteristics, but are artificially associated by the patch through the triggering of events based on the detection of amplitude attacks from the CD output. In a similar way, the software element in **hawaiian** (6) operates ‘in the middle’ of the sounds produced by the mechanical slide-guitar and the recordings reproduced by the CD player, the pitch of the synthesised tone being derived from the frequency relationship between the two sources. In **rickety-tick** (5) the software forces pre-recorded rhythmic soundfiles and live, freely-improvised material together into the same tempo. This patch is also in part a modified version of a program I named *Exploding Elastic Inevitable*[38] (derived from the code used in ‘duet’, which in turn is a modified version of an example patch), allowing recorded material from the toy-piano and circuit-bent sound-module to be time-stretched and compressed in and out of time with each other.

This explicit combination of modification and design (on my part alone – the technologies employed in these examples must surely have arisen from similarly combined approaches) on one level is an attempt to address an issue of wide concern in activities dealing specifically with ‘technology’, stated clearly by Achim Szepanksi in his article *A Mille Plateaux Manifesto*:

> “Today, we can ask the question: Who is the originator of the act, the programmer, the software or the hardware? The knowledge about mechanical processing, the internal signal control, shows that programmers have been acting as designers for a long period of time”[39]

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[38] http://www.ariada.ac.uk
[39] Szepanski, A. (2002) p226.

Or, to what extent can we claim individual responsibilty for the ‘design’ of something, be it a piece of software, hardware or music? In a more sociological approach, Paul Théberge writes of the increasingly sophisticated and abstract relationship electronic music makers have with technology that:

> “Software, at least, gives the musician a graphic, visual representation of the data required in sound programming. Here again, this situation merely reinforces the position of the musician as a ‘consumer’ of new technologies. As Peter Lyman has pointed out in his discussion of computer word processing: ‘[A] computer is both a machine and a social relation. Computer ‘hardware’ can only be used with computer ‘software’, and software is essentially a technical culture which defines the practical techniques necessary to operate the machine, as well as an implicit theory of knowledge (information theory or cybernetics) and implicit social relationships as well (the consumer as ‘user’, the computer as provider, and others). One must be an expert to consume the hardware without the software; few experts could do so.’[40]”[41]

Similarly, Szepanksi argues that this situation produces music which is:

> “[T]he result of the teamwork of numerous authorities such as the ‘musician’, the programmer and the authority of the software program… [A] given program secretly directs the programmer towards significant ways of performing, creating apparently absolute relationships”[42].

Here, Szepanski and Théberge are focusing primarily on computer software, but the same question is equally as relevant to hardware devices, and practically any tool. The interfaces we are presented with by our technology can influence the way in which they are conceived of and utilised almost regardless of the actual properties of the technology itself. Contrasting electronic musical instruments with their more traditional acoustic counterparts, Théberge claims:

> “The more or less direct relationship between physical gesture and sound that is characteristic of most traditional musical instruments is completely severed with electronic devices. For example, despite its conventional appearance, the keyboard of a synthesiser or sampler is an ‘interface’, little more than an elaborate switching device; thus, the relationship between gesture and resulting sound (i.e., the manner and the degree to which a sound responds to the body through touch, breath, etc.) becomes entirely arbitrary, something to be rationally planned for as part of the overall characteristics of the sound program… Decisions made by engineering teams at the early design stages of a processing device can thus have a profound impact not only on the ability to make use

[40] Lyman P. (1984) p.75-89.
[41] Théberge, P. (1997) p.212.
[42] Szepanski, A. (2002) p.225.

> of the device but also on musical/compositional practices and concepts."[43]

While this clearly isn't the case for *all* electronic devices – the *theremin*, for instance, has a very 'direct realtionship between physical gesture and sound', more so than many acoustic instruments, as does the modified 'voice-changer' used in **tango** (10) described earlier – the more abstract and complex the device becomes, the more Théberge's claim holds true. By using and consuming technology in the ways described here, by acknowledging that programming is in some senses the act of rearranging prescribed objects into certain combinations rather than freely designing and realising something uncritically 'new', and by directly intervening in the electronic processes of technology - changing the 'decisions made by engineering teams at the early design stages' of a device – it is possible to recognise, exploit, and to some extent sidestep the problematic nature of these relationships.

[43] Théberge, P. (1997) p.199-200.

Digital / Mechanical

Ever since tentatively removing the casing of the first object I attempted to modify, a CD walkman, my attitude towards the received connotations associated with objects considered to be 'digital' or 'mechanical' has changed considerably. Upon opening the device – something I had used unthinkingly nearly every day for the previous ten years – I was struck by the seeming incongruity of technologies involved in its operation. Occupying almost exactly one half of the Discman was the circuitboard: miniature components intricately arranged and interconnected, each labeled neatly and consistently. The other half was purely mechanical: small motors, gears, the plastic sled which carries the laser - all covered in scrawled, handwritten text and stickers bearing serial numbers in a variety of typefaces.

This seemed to be a 'hidden' side of the technology, willfully suppressed in the manner in which it is marketed. The media's predilection with the labeling of products as 'digital' has helped to perpetuate the notion that the term is synonymous with everything desirable: modernity, clarity, flexibility, sophistication, miniaturisation. At the time of writing, for instance, a television commercial for a digital camera begins with the words 'digital is great!', and even such obviously non-digital products as batteries and headphones are labeled as 'digital' in an attempt to associate them with this assertion. By implication, therefore, non or partly-digital, mechanical devices are 'less than' digital – outdated, simple, clunky, undesirable. This can be seen, for instance, in the design arc of computer CD-Rom drives where the 'tray loading' style of drive which reveals the spindle motor and laser-positioning sled has been superceded by a 'slot loading' design, further concealing the inner workings of the mechanism.

'Digital Music' has become synonymous with 'Computer Music'. Furthermore, the desirable qualities claimed for 'digital technology' – flexibility, precision, sophistication – are associated predominately with software. Other examples of devices which make use of digital systems, for instance musical keyboards, CD players, printers – primarily hardware-based equipment – retain associations of fixity, singularity.

In the first piece in which I utilised a modified CD player, **CD err** (2), the exploration of the relationships between the 'digital' (software) and 'mechanical' (CD player) aspects happens 'offline', out of real-time. The modification of the CD player allows for an additional manual control panel, which, much like the conventional user controls, triggers connections between components inside the device. These supplementary controls variously expose normally unheard steps in the digital-to-analogue conversion chain, sonify signals relating to the operation of the internal motors, or send abnormal signals to the motors causing anomalies in the linear playback of the CD.

hawaiian (6) came about as an explication and exploration of the technological incongruity of the CD player, with the mechanical half of the Discman being exploded and foregrounded rather than concealed. There are three distinct elements in this study, each connected to the others in a variety of ways.

The first element is a mechanical instrument built almost entirely from parts of CD players, modeled on the principle of a single-string electric slide guitar[44]. The sled on which the laser is usually mounted is inverted and supported by a cradle constructed from a bent coat-hanger. The place of the laser is taken by a metal ‘slide’ (the outside casing of an XLR connector) which moves along the string to alter its pitch, while the central spindle motor which rotated the CD powers a plucking arm to play it. The base of the machine is the sled mounting from a second portable CD player, and an electric guitar pickup and two machine-heads are attached to hold and amplify the string.

The second is a Sony Discman, unmodified except for the bypassing of its ‘mute’ signal and two additional wires, one end of each of which is connected to the points on the circuit board which control the laser sled motor.

The third element is a *Supercollider* patch running on an Apple G3 Powerbook which pitch-follows the two sound sources (CD player and mechanical guitar) and synthesises a third voice using a software-simulated [Formant][45] oscillator, the frequency of which is dependent upon the relationship between the detected pitches of the other sounds. These components therefore range from the purely mechanical (guitar), to the purely digital (*Supercollider* patch), with the CD player ‘inbetween’, and they connect and interrelate in various ways.

The two wires from the circuit-board of the CD player are attached to the sled motor on the slide guitar. In this way the same signal is sent to both motors from a single controlling circuit board, causing the two sleds to move identically, but performing differing functions. Whereas the one in its conventional position inside the CD player determines a temporal dimension to the sound – how far from the beginning of the CD to read the data - the second, inverted sled controls frequency – the pitch at which the string sounds when it is plucked. Additionally, a fraction of this same signal is sent via a potentiometer to the motor which plucks the string, creating a correlation between the movements of the two motors, and therefore of the timings of pitch change and the sounding of the notes. The ‘plucking arm’ motor is also connected to the USB port of the Powerbook via a hacked mobile phone charger. This draws current from the computer through the USB protocol to power the motor in addition to the signals sent from the CD player. Furthermore, as the CD player motor and the ‘plucking arm’ motor are connected, the current drawn from the computer also has an effect on the position of the laser of the CD player (although, as stated earlier, the intermediating potentiometer limits this effect considerably, ensuring it doesn’t disrupt the playback to a detrimental degree).

A further connection is established by routing the sound output of the CD player and the slide guitar to the sound input of the Powerbook, allowing the *Supercollider* patch to synthesise a third sonic element related to the frequencies it detects in the other

[44] Fig. 7.
[45] Supercollider’s [Formant] object is described in its help file as “generat[ing] a set of harmonics around a formant frequency at a given fundamental frequency.”

two. The amount of power drawn from the computer by the USB phone charger varies according to the other functions it is performing at the time, so the essentially very simple *Supercollider* patch involved in this piece contains chunks of irrelevant, redundant code whose only function is to consume processing power in order to modulate the amount of current transmitted through the USB cable, and therefore its effect on the speed of the motor. This is achieved through the creation of an array of 175 instances of simulated sine wave oscillators, none of which are routed to the sound output, and which are individually switched on and off using *Supercollider*'s [Pause] object. As its name suggests, this object 'pauses' audio processes when they are not needed, allowing others to run by freeing up CPU power when the tasks are inactive. By randomly pausing and unpausing each of these sine wave oscillator objects, the program's CPU usage is made to fluctuate, resulting in a varying amount of current being sent via USB to the slide guitar motor.

This network of differing mechanical and digital relationships is a reflection and development of the connections within the CD player, an exploration of alternative ways in which the components can interact and interrelate. The piece is not intended to be a facile reversing of situation or function: taking the 'inside' and presenting it 'outside', or even a declaration that the mechanical moving parts of such devices should be made more evident by manufacturers (there are, of course, many practical reasons why they are not). Instead it is intended rather as a creative refiguring and repurposing of the pre-existing mechanical elements, born of my surprise and curiosity aroused by the disparity between the technologies required for the CD player to function.

latin (9) follows this same line of thinking, this time utilising the components which make up an inkjet printer[46]. This is also, in essence, a device which mechanically transposes digital information into the 'real world', a digital to analogue converter. The mechanical elements are too, in some ways, similar to those involved in the CD player – two motors, one which needs to revolve in only one direction (the CD player's spindle motor which rotates the disc, the printer's paper feed motor), and one which determines the position of a sled, able to move in two directions (the CD player's laser, to read information, and the printer's print head to write it). The motors are, again, transposed to operate acoustic, mechanical instruments – this time percussive rather than melodic, and constructed from pens, a pencil, pieces of wood and cable-ties.

It was important to me that this would be something to watch when it is in motion, as this seems to be the general everyday relationship between the user and the printer. People *watch* their printer at work, possibly out of mis-trust of the technology – will the hard copy match what I intended on the screen? They wait for the paper to re-emerge, for the printer to complete its task before carrying on with theirs. The action of the mechanical instruments in this piece was designed to connote this impatience, the sounds created by the instrument being a combination of background motor noise and the idle tapping of pens and pencils. The object exists, then, as a musical manifestation of people's relationship with itself, a reflection of the way it is conventionally treated. In this crude 'text to music conversion' system, the absolute abstraction of binary code is revealed and exploited in a mechanical way, allowing

[46] Fig. 8.

data originally intended for the reproduction of text to be repurposed for the production of sound. At the same time, the mechanical elements are shown to have the same flexibility and possibility for translation and re-mapping as that associated with digitally coded information. This is an attempt to address the way that "today, computer digital music can be seen as screen-based music, i.e. sounds become visible and images audible"[47] at the same time as destabilising the "apparently absolute relationships between image and sound"[48].

Initially, my concept for **tango** (10) was to connect the tone-arm of a turntable to the laser-sled of a CD player using string and a pulley system so that the two playback mechanisms would be mutually influential – the digital would no longer be in sole control of the mechanical[49]. After a few unsuccessful experiments, I changed the forces involved in the piece to two identical CD walkmen and set up a system where they exchanged motor-control signals whilst being set on 'random play'. In this way each CD player controlled the play position of the other, starting and stopping mid-track and interrupting the standard manner of operation. While this generally worked from a technical standpoint (not completely, however, as it did cause the devices to 'crash' from time to time), aesthetically the results were much less interesting and much more repetitive than I had hoped. By intervening in and 'confusing' the precise positioning of the laser sled, sending multiple signals to a single motor, the absolute control previously wielded by the digital circuit is disrupted in each of the devices, replaced with competing influences and erratic playback.

In an article discussing the creative misuse of CD technology in the work of Nic Collins, Yasunao Tone and Oval, Caleb Stuart describes the technical process by which anomalous sounds and skipping playback are produced by glitches in the system:

> "The glitches heard form a CD player – the skips and stutters – are not caused by actual skips; the CD player's laser does not actually 'stick' in the way a phonograph needle becomes physically locked in a groove. Instead, the skips and stutters that we hear when playing a CD are errors being emitted from the system as audio. The ticks and pops are due to binary values being read incorrectly – if the level of the error is so great that the error-correction software driving the digital system is not able to cope, it emits false sounds."[50]

Whilst this is true for the irregular *sounds* produced - the 'ticks and pops' which emerge from an overloading error-correction system – the *structural* inconsistencies,

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[47] Szepanski, A. (2002) p225.
[48] Ibid.
[49] Coincidentally, Satoru Ono, artistic director of the *Maywa Denki* company / musical theatre ensemble incorporated a similar result, albeit from a manual technique, on his 1998 CD *Sauvage* (Kaeru Café KACA0058) where he "lets the needle fall on the record at regular intervals, recreating a reductionist skeleton of a tango." (Loubet E. (2000) p28).
[50] Stuart, C. (2003) p48.

on the other hand – the ‘skips and stutters’ – are at least partly related to physical, mechanical causes. While the CD player laser does not read the information from a CD in the same physical way as a turntable needle ‘reads’ the information on a vinyl record, the basic concept used for both systems is remarkably similar – a spinning disc with a moving ‘needle’ – and the positioning mechanism of the CD player’s laser is also a mechanical one. Unlike a vinyl record, however, a CD also holds information pertaining to ‘time’ as well as ‘sound’, information which is read by the laser and used to determine the correct position of the sled by activating the motor. If this data is read incorrectly, therefore, it is not ‘emitted from the system as audio’, rather it causes the device to move the sled to the ‘wrong’ place, resulting in ‘skips and stutters’. Although this effect is produced by the misreading of *digital* information, the manner in which this occurs is usually a purely physical one – the accidental accumulation of dust and scratches on the surface of a CD through overuse or neglect, the deliberate ‘preparation’ of CDs using clear tape, ink or paint - refracting and obfuscating the precise binary data through ‘real world’, everyday detritus. Furthermore, in performance both Yasunao Tone and Nicolas Collins physically manipulate this mechanism, exploiting its mechanical properties:

> “Tone would literally bang the player with his hand to cause it to jump from one glitch to the next – just where it would stop and on which sound it would stutter could not be known from one playing to the next”[51]

Performing this action on a ‘purely’ digital system such as a computer would not have the same effect. In the cases of **hawaiian** (6) and **tango** (10) described above, the mechanical positioning system is subjected to further ‘outside’ influence from the fluctuating current of the computer’s USB port (**hawaiian** (6)) and signals from another CD player (**tango** (10))

The modified toy piano and sound-module utilised in **rickety-tick** (5) is a reversal of this relationship, with mechanical control affecting the operation of digital devices. The system is intended as a parody of the MIDI paradigm where a ‘silent’ MIDI keyboard arbitrates the relationship between player and sound production. This model is retained in some aspects, the keyboard mechanism and direction of the flow of information remain essentially the same, yet in place of the transmission of MIDI information, the behaviour of the sound-module in this instance is influenced by the completion of electrical connections on its own circuit-board, activated by the depressing of the toy piano keys. This coupling produces a very different type of ‘control’ relationship than the standard ‘note on’ / ‘velocity’ messages which trigger the production of a single sound. The conventional playing method of the toy piano is used instead to unpredictably re-route signals between components and send digital circuit-noise to the sound output, contradicting the perceived model of digital accuracy and reproducibility. The “fixed-timbre fixed-role orchestration model”[52] of General MIDI instruments embodied in the Roland sound module is overturned in favour of highlighting the ‘sounds’ of the circuitry necessary to enforce this protocol.

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[51] Ibid.

[52] Waters, S. (2003). P.166.

A similar 'confusion' of digital information is achieved in **jazz** (7 + 8) as the real-time re-wiring of the Yamaha Portasound PSS-380 keyboard bypasses the conventional mechanical keyboard to directly reconfigure the signal pathways and disrupt the fixed relationship of the interface. The interchangeability of digitally coded information is creatively misused to corrupt and exchange the pre-programmed files pertaining to rhythmic, pitch and timbral parameters used by the keyboard in its typical operation.

The conventional models regarding the relationships between digital and mechanical elements generally consist of precise digital systems controlling mechanical components (CD player, printer) or human-operated mechanical interfaces sending control information to digital systems (MIDI keyboard, computer interfaces). In the works presented here I have taken a deliberately 'messier' standpoint, attempting to question the assumptions made about what certain technologies *should* do, and to explore alternative networks and relationships involving the essential components and technologies inherent in existing devices.

Describing his *Mechanical Sound Orchestra* - a collection of giant, industrial sound-making machines – Matt Heckert details the process by which he goes about "controlling it with very long electronic fingers"[53]:

> "Continuous [MIDI] controllers are used to vary motor speeds and note events are used for switching transistors, and it is this information that is recorded by the software. Once recorded and stored as a sequence or sub-sequence, any series of control commands can be used at any time. When called up from the computer keyboard, controller information is sent out instantly and the system responds much like any MIDI controlled electronic instrument, but the big differences are the inertial delay encountered when stirring a machine out of rest"[54].

Here the digital precision and exact repeatability afforded by the MIDI protocol is contrasted with the unpredictability and inertias of massive, physical machines. Whilst this one-way process illustrates perfectly one of the problematic issues regarding digital systems – namely that digital abstraction, 'precision' and reproduction are all well and good until the time comes for the information to leave the system and be transposed into the 'real world' – I have been more interested in playing with the connotations surrounding ideas of the 'digital' and the 'mechanical'. My mechanical devices are not large and industrial, constructed from "[a] lot of metal and wire... [h]uge equipment, rusting gears"[55], rather they are small, fragile – collages of other machines and technologies. They do not perform the same repetitive actions *ad infinitum* or require direct human control to function, their operation is dependent on the interaction of multiple forces – human, mechanical and digital.

The digital technologies employed are similarly not those typically considered when thinking of 'digital technology' (i.e. computers), and they are made to operate in a

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[53] Heckert, M. (1996).
[54] Ars Electronica (1997).
[55] Heckert, M. (1996).

manner unlike the precise, flawless one they superficially present. Digital systems are 'confused', interrupted, re-routed to produce unforeseen, unpredictable results. When software is employed, it is not simply used for its accepted properties, to unerringly analyse input and control hardware, other possibilities are explored in conjunction with mechanical devices, alternative networks are investigated. The relationships between devices, both mechanical and digital, are not simply those of unidirectional data transfer or control, but involve mutual influences and feedback, creating new sets of systems which produce unrepeatable sonic results from the interrelated operation of their individual elements. The micro-scale technological incongruities identified, investigated and explored can be seen as being analogous to the situation described in this (much larger-scale) account by Jonathan Crary:

> "The charade of technological 'revolution' is founded on the myth of the rationality and inevitability of a computer-centred world. From all sides, a postindustrial society is depicted that renders invisible the very unworkability and disorder of present 'industrial' systems of distribution and circulation. Telecommunications and Paul Virilio's world of absolute speed will not supplant highway / railroad space, but instead these two domains will co-exist side by side in all their radical incompatibility. It is within the dislocation of this 'unthinkable' interfacing that the present must be conceived"[56].

While Heckett's mechanical experiments result primarily in 'instruments' to be 'played', I have largely tried to create devices which display some form of autonomy in their actions. 'Automatic music' has been a popular pursuit for centuries; since 1650 when the Jesuit polymath Athanasius Kircher

> "invented an eccentric collection of mechanical devices that generated, amplified and ordered sound… A brisk luxury trade in musical [automata]… only declined with World War One as other forms of recorded sound became more widely available. This evolutionary obsolescence inevitably becomes a sign of mutated history within the work of composers and performers who create with machines, whether Conlon Nancarrow's or James Tenney's composition for player-pianos, Stockhausen's *Zodiac* piece for music boxes, or the post-John Cage, post-Grandmaster Flash turntablism of Philip Jeck, Project Dark, Christian Marclay or DJ Disk."[57]

While these 'luxury' automata fulfilled the role of later, more widely available recording technology, recently mechanical devices, automata, and robots have been evaluated both in terms of their functional and their aesthetic qualities, with some artists declaring the creation of such devices "the ultimate extension of sculpture…inherently art, regardless of their physical form."[58]

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[56]Crary, J. (1991) p.290.
[57] Toop, D. (2003) p.118-119.
[58] Cannon, B. (1993-2003).

An optimistic belief in the sci-fi images of robotics is still maintained in Japan where an illustration from a guide to Osaka published in 1798 shows a *karakuri* performance involving live performers and a mechanical, drum-beating cockerel. Mary Hillier describes the influence of such devices on Japanese culture as follows: "Just as the European automata of men like Vaucanson anticipated the machines of the industrial revolution, the Japanese performance of *karakuri* was an awakening of automation."[59]

Continuing in this vein are the Japanese 'art unit' *Maywa Denki*[60] who sympathise with this dream of improving the world through such inventions, and "[a]t the same time, they poke fun at the society created by those high-tech advances."[61] Situated somewhere between instruments, *objets d'arts*, and mass-produced, technology-conscious commodities, the objects they create are "'low-tech' parodies of high-tech merchandise"[62]. Adopting a particularly Japanese approach Masamichi Tosa, *Maywa Denki*'s founder, named and even styled the collective after his father's now defunct electronics company. All members of the group wear costumes "designed as a typical working uniform of Japanese electric stores, symbolizing small/medium-sized enterprises that had once supported Japan's economy during its high-growth period"[63], and their language reflects this approach. Each of their works is called a 'product' and a live *Maywa Denki* concert performance is termed a 'product demonstration'. They market the invented instruments they play under the name *Tsukuba Series*, described by the group as "musical device[s] played by physical movement of motors and/or electromagnets at 100V. It is not information but machine-music materially performed by electric-powered musical instrument."[64] These instruments include an electric musical saw (*Saw-two-bow*), six acoustic guitars played by remote control with a pedal organ (*Guitar-la*), and ultra-loud Klaxons with flashing lights in the shape of a saxophone (*Takedamaru*). Whilst *Maywa Denki*'s attitude in some ways expresses a "nostalgia for a pre-technological time"[65], their works are as technologically sophisticated as they are silly, and expertly crafted – directly at odds with Matt Heckert's huge industrial structures. This idea of 'mass-production' is also a feature of the objects I have chosen to use, but approached from the opposite direction. Whereas *Maywa Denki* produce nonsensical electro-mechanical musical instruments and then market them as art 'products', I have taken mass-produced products and turned them into nonsensical electro-mechanical musical instruments. The 'active production' / 'passive consumption' of commodities is reversed as an individual, personal and non-productivist set of objects is created.

Along with Matt Heckert and *Maywa Denki*, one of the most prominent musicians working with mechanical instruments is Pierre Bastien, who has built a homemade mechanical orchestra, the *Mecanium*, from Meccano kits powered by turntable motors. This "failsafe orchestra"[66] performs on household objects such as scissors and

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[59] Hillier, M. (1988).
[60] Also spelt *Meiwa Denki* in some instances.
[61] Itoi, K. (1998).
[62] Ibid
[63] http://www.maywadenki.com/top.html
[64] http://www.maywadenki.com/tsukuba/index.html
[65] Itoi, K. (1998).
[66] http://www.pierrebastien.com/en/biography.html

ashtrays as well as traditional acoustic instruments from around the world, plucking, bowing and striking a variety of sound-making objects.

Bastien cites as his main influence the French novelist and poet Raymond Roussel, whose "fantastic inventions lay in an interzone between vaudeville, anthropological Surrealism and future audio art. A fictive art that was improbable yet tantalisingly possible."[67] Roussel's vivid descriptions of imaginary music-making activities mirrored his own convoluted writing processes; just as he follows a highly circuitous set of linguistic games, puns and associations to produce narratives which are largely fairy-tale or allegorical in nature, so "his musicians devote all their ingenuity to finding fabulous ways of performing conventional styles of music."[68] In a similar "netherworld of science and mysticism"[69] to Kircher's late Renaissance designs, Roussel's descriptions include "a cripple without legs or arms who still manages to perform as a one-man band on a set of pan-pipes, an accordion, a triangle, drum and cymbals"[70], "[a] harp whose strings are made from wax tears shed by the wives of fifteen brothers"[71] and a worm in a transparent trough filled with a strange 'heavy water' suspended above a zither, who "is able to regulate the flow of drops of heavy water on to the strings of the zither…[and] faultlessly executes wondrously complex Hungarian rhapsodies with a 'savagely dramatic range of expression'"[72]. Of particular interest to Bastien, he claims, was a passage in Roussel's 1911 novel *Impressions D'Afrique*

> "…describing an automatic orchestra which is built under a closed glass box. And the scientist who builds the orchestra has previously invented a new metal which can react very quickly to small changes in temperature. So in order to demonstrate his inventions he builds this orchestra with pipes, with different kinds of drums, and a lot of musical systems. He has invented what he calls a 'thermodynamic orchestra', and the description in the book is so precise that this induced me to produce something equivalent. I wanted to produce such an orchestra, not a thermodynamic one of course, but automatic."[73]

Roussel's influence on my thinking was not so much a matter of suggesting the creation of an 'automatic orchestra' as it was about the connections between things. A worm on its own is not particularly interesting, neither is a zither, but a worm 'connected' to a zither in order to make music becomes significantly more interesting. One account describes a bereaved father taking

> "a heterogeneous array of objects that include, among many others, a thread capable of sewing itself, a holy wooden memory-aid engraved with Coptic letters, a ruler made of bacon, a set of golden

[67] Toop, D. (2003) p.122.
[68] Ford, M. (2000) p.33.
[69] Toop, D. (2003) p.118.
[70] Ford, M. (2000) p.32.
[71] ibid p.126
[72] ibid p.32
[73] Shin, N. (1995).

> hinges and a primitive recording apparatus, all of which he combines in a series of complex operations that eventually enable him to produce a sound exactly resembling his young daughter's baby-talk."[74]

The idea that such things could be combined to create sound was a powerful one, even if some of the objects were improbable, if not impossible. It made the concept of connecting an inkjet printer, cable-ties, pens, a pencil and small blocks of wood to make music no more absurd than connecting a cello, flute or trumpet to a computer for the same reason (i.e. only fairly absurd).

There is no doubting the deliberately absurd qualities of Bastien's Mecanium or of *Maywa Denki*'s 'products', qualities which arise largely from the redundancy of mechanical music production in the age of digital reproduction. The idea of something non-human, be it a worm or a meccano robot, performing an activity we associate with 'humanity' - physically producing sounds which we can recognise as 'musical' - still has a considerable emotional and visual impact.

On one hand this impact is no longer one of wonderment at the complex, intricate technology being used, instead it is wonderment that this technology is *still* being used. On the other, the decline in the popularity of mechanical musical automata and therefore people's exposure to and familiarity with their workings, has meant that they can once again cause surprise.

Mechanical music-making devices, more so than other, related objects such as kinetic sound sculptures, project a specific 'lack' – no matter how sophisticated and intricate the mechanism is, the 'human' qualities of 'music making', a quintessentially human preoccupation, are absent. While digital, software-based musical automata can be viewed to have a certain type of 'musical intelligence' by a listener, mechanical automata become imbued with *life*. With few exceptions such as Nicolas Baginsky's *the Muses of the Other World* in which machines which are "partly robots, partly music instrument"[75] use neural nets to "develop pure 'inhumane music'"[76], musical automata (often deliberately) tend to exhibit mechanistic behaviours which fail to capture the nuances and subtleties of human activities. The kinetic and robotic artist Bruce Cannon's description of his work encapsulates this phenomenon:

> "While some of the pieces manage to exhibit lifelike behaviours despite their technical limitations, my general approach is to construct objects whose behaviours are in some ways lifelike yet which embody little of the richness of being. These machines' failure to transcend their artificiality is their most significant aspect. The pieces are not so much lifelike as referential to being, and what is missing is what resonates for me. I have come to think of this negative space as the place where the work happens, at its best a sort of electro-mechanical Haiku in which randomness and absence

[74] Ford, M. (2000) p.125.
[75] Baginsky, N.
[76] Wilson, S. (2002) p.431.

> generate issues of sentience and presence which I would be unable to evoke directly."[77]

As humans performing repetitive actions become seen to be 'mechanistic', their bodies relying less on conscious direction and more on repeating patterns of muscle movement, so machines behaving 'randomly' and erratically gain connotations of life, of humanity. Describing the implementation of 'humanising' functions in MIDI sequencers in which grid-quantised MIDI events are shifted slightly in time with the hope of producing a more 'human' feel to the music, Paul Théberge notes that "[w]hat is interesting here is how the 'human' has been defined, primarily within technical culture, as 'random'"[78]. In these pieces I have tried to play with these connotations as they pertain to 'digital' and 'mechanical' systems and devices, creating hybrid automata which go against their presupposed natures and which are neither fully controlled by nor in control of their human counterparts.

Whilst the anachronistic qualities described above are welcomed and played with in pieces such as **hawaiian** (6), **latin** (9) and to some extent **tango** (10), the elements involved dictate that these objects could not have been created at any other time. The mechanical devices involved in these pieces are not created from scratch using meccano or industrial scrap metal, they wear the signs of their previous identities clearly. The adaptation of a CD player, able to reproduce any sound recorded onto compact disc, into a crude mechanical instrument with a restricted range of pitch, dynamic and timbral possibilities is in no way an augmentation of the device – it is an absurd construction. The same can be said for the other objects – a mediated electronic keyboard which turns the information from barcodes into streams of sound, a wooden toy piano which controls a MIDI sound-module, and a printer which plays percussive rhythms on assorted stationery items – none of these improve on the efficiency or level of technological sophistication of the original devices. Instead, the collision of opaque, unfathomable digital systems – the contemporary equivalents of magical 'mercurial water' and super-sensitive thermodynamic metals – and primitive, exposed physical mechanisms *without any mediating 'interface'* - no MIDI converter, *I-Cube*[79] or *Sensorlab*[80] - illustrates direct connective possibilities and recalls Jonathan Crary's claim quoted earlier. The absurd modification and diminished capacity of the digital devices embodies a further assertion of his that:

> "We must recognize the fundamental incapacity of capitalism ever to rationalize the circuit between body and computer keyboard, and realize that this circuit is the site of a latent but potentially volatile disequilibrium. The disciplinary apparatus of digital culture poses as a self-sufficient, self-enclosed structure without avenues of escape, with no outside. Its myths of necessity, ubiquity, efficiency, of instantaneity require dismantling: in part, by disrupting the separation of cellularity, by refusing productivist injunctions, by inducing slow speeds and inhabiting silences."[81]

[77] Cannon, B. (1993-2003).
[78] Théberge, P. (1997) p.226.
[79] http://www.i-cubex.com
[80] http://www.steim.org/steim/sensor.html
[81] Crary, J. (1991) p.294.

The literal and metaphorical dismantling of the digital "self-enclosed structure" and its intersection with physical, mechanical systems in polydirectional 'control' relationships in this 'irrational', absurd way can result in musical objects and structures which hopefully go some way toward exploding these myths.

Precision / Chance

"Interesting is halfway between nothing and random" (Alan Rath)[82]

The acknowledgement and celebration of the role of chance in musical composition is a phenomenon generally associated with the postmodern experiments of John Cage *et al*, but long before Cage's utilisation of the *I Ching*, Mozart is reputed to have used dice to determine the ordering of sections in a minuet, and "in 1751 William Hayes 'wrote' the composition *The Art Of Composing Music By A Method Entirely New, Suited To The Meanest Capacity* by flicking ink at manuscript paper."[83] The use of random factors to determine musical events has been popular with musicians ranging from the conceptually-driven to the merely indecisive (I must admit to being both at times), but, as Joel Chadabe puts it, "[t]he question is 'how, exactly, do you use random numbers?'"[84] In all of the pieces presented here, chance, unpredictability, coincidence all play a large part – in terms of their construction, large-scale structure, micro-scale organisation of sound and the sounds themselves. The relationships between precise, stable, predictable elements and aleatoric, coincidental factors vary from piece to piece and it is the 'how's and 'why's of the ways in which these aspects are used which will be examined.

The principle employed in **duet** (1), for example, is one of both precise, preset data and unpredictable outcomes. The *Supercollider* patch consists of a set of tables which contain predetermined values pertaining to the parameters of the DSP processes through which the live performer's sound in fed. In some cases the data in the tables exerts direct control over an aspect of the processing, such as the amount of pitch shifting to be applied or the extent to which a loop should be time-compressed or expanded. Most parameters, however, treat the data as levels of probability rather than absolute values to apply to the effects. The timing of the recording of new material into the software's loop buffer, for example, is one such probability-based element, meaning that the likelihood of the live sound being recorded and replayed can be set over time, but not the specific moments at which it will happen. This gives the performer precise control over the general 'shape' of the software sound processing, but results in less predictable small-scale sonic organisation. The piece is 'scored' absolutely through the use of these tables, whilst the indeterminacies they represent produce a different result in each instance of performance – not to mention the inherent unrepeatability and chance inherent in improvisation or even interpretation of a scored composition. Whilst it is conceivable, for example, that an instance of this patch could be used in conjunction with an entirely pre-composed instrumental part, the intrinsic chance aspects would effect the outcome differently each time.

tango (10) and **hawaiian** (6) both make use of the remarkable, Cagean (and possibly slightly serialist) 'shuffle' or 'random play' function built into the CD players used in

[82] Tromble, M. (1998).
[83] Hamilton, A. (2003) p.210.
[84] Chadabe, J. (1997) p.270.

their realisation. The ability to play tracks in a random order incorporated with the more invasive interventions in the linear playback employed in the pieces has proved to be a useful method of material arrangement. In these pieces short musical fragments (often only 3 seconds long, the shortest track length permitted by the CD format) are recorded onto CD and replayed with the CD in 'shuffle' mode. These fragments are 'composed' in such a way that they share internal consistencies to certain extents with regard to 'style', pacing, pitch and other salient factors, and in much the same way as Henry Cowell's 'elastic notations' required the performers to assemble a selection of fragments to form the 'finished piece', the order of the sections is decided by the machines.

Their involvement in the realisation of these pieces does not end there, however, and their role is not simply to 'roll a die' to determine the ordering of material. The 'prepared' CD which stores the raw material for **hawaiian** (6)[85] and the multiple, competing signals affecting the playback of the devices in **tango** (10) cause further indeterminate results. The sounds can be 'compressed' by the device, skipping forward whilst playing or prematurely moving to another track, cutting the fragment short. The instabilities can also 'expand' the material, 'rewinding' through the track or replaying sections, stuttering and sticking. The incorporation of these indeterminate elements and a knowledge of the types of effects they produce also informs the decision-making process regarding the nature of the material which will be used on CD in the piece. Trial-and-error experimentation with various types of musical material coupled with this growing familiarity with the nature of the likely transformations which would occur resulted in changes to the final material used and also influenced the arrangement and frequency of the occurrence of each fragment on the tracklisting – as the CD is set to 'random play', each track can only be repeated once all other tracks have been played. For both of these pieces I experimented with varying lengths of tracks and differing fragments, burning CD after CD, making small changes until the results produced the 'right kind' of unpredictability. In **hawaiian** (6) the physical preparation of the CD also required a very precise balance between 'straight' and altered playback – too few imperfections on the surface of the CD and the disruptions were uninteresting, too many and the disc refused to play at all.

The same balance was needed when working on the *Supercollider* patch used in **hawaiian** (6). Using *Supercollider*'s [Pitch] object, the code attempts to detect the frequency of the two inputs being fed into the computer (the outputs of the CD player and the mechanical slide guitar), a task it performs with comparative accuracy if the inputs are single note melodies, but when the signal consists of wider, more complex frequency bands it yields substantially more erratic results. This is compounded by the inclusion of code intended purely to consume processing power, periodically pushing the CPU usage above 100%, which reduces the precision of the pitch-detection and can interrupt the sound production of the sysnthesised tone produced by the patch. Heavily overloading the CPU caused the computer to crash, while letting the processor usage fall too low made no impact on the operation of the program. This works both as a method of destabilising the frequency detection and of controlling the timing of the synthesised software voice as the sound cuts in and out.

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This is a theme which runs through all the pieces - precise digital systems subjected to manipulations and usages unforeseen by the manufacturers, causing them to operate in unexpected ways. The interest lies in seeing how far something can be 'pushed' before it breaks, stops or becomes 'predictably unpredictable', i.e. completely random. The device is 'trying' to perform the functions is was designed to do – to reproduce sound recordings, to print text, to play back pre-programmed musical sequences – yet extreme modifications and interventions disrupt the process but not to the point of collapse. This fine balance itself requires very precise tuning to produce the desired chance results.

The 'control', for instance, wielded by the performer in **jazz** (7 + 8) is a very different one to the standard notion employed in most instrument / performer relationships. Raymond Scott's *Electronium* mentioned earlier and Salvatore Martirano's 1972 construction, the *SalMar* are both instances of musical devices which require *guidance* rather than *control* – in fact Martirano declares

> "Control was an illusion. But I was in the loop. I was trading swaps with the logic. I enabled paths. Or better, I steered. It was like driving a bus."[86]

The performer in **jazz** (7 + 8) has less direct control and recourse to fewer predictable outcomes than the descriptions of these machines suggests, becoming more akin to constantly *learning* to drive a bus, or driving something which starts out as a bus, but which constantly transforms into different vehicles the more you steer it.

The improviser in this instance influences the overall structure of the piece and to some extent the *kind* of material which is produced and its subsequent development, but responsibility for the actual detail and minutiae of the sound is deferred to the machine. This deferral, and the manner in which it is achieved – the re-routing and 'confusion' of complex electronic signals – produces results which are unpredictable for the performer and the audience, but which emerge due to the combination of numerous stable and precise systems. A selective list of reliable, repeatable short-circuits which can be made on the Yamaha Portasound PSS-380 circuit-board - produce fast twittering noises that pan left and right, initiate a corrupted auto-accompaniment pattern at a random tempo, make the drum sounds 'crunchy' - reads more like an extract from Jorges Luis Borges' oft-quoted 'certain Chinese encyclopaedia'[87] than a set of control possibilities. In contrast to the standard parameters of pitch, duration and volume, the performer plays with stylistic recognisability, rate of change of material, levels of autonomy and unpredictability. In this piece and in **rickety-tick** (5) the experience of performance is distinctly different to that of a piece involving 'conventional' musical instruments. In place of consideration of how their actions will affect the current sound being produced or how best to play the next note or sound, the performer must reflect on how to coax the device into playing the desired kind of material or react to situations in which unwanted material is produced. Unlike traditional interfaces the same action does not necessarily produce the same result each time, so the device can thwart the designs of its operator, forcing them to constantly re-engage with the instrument and the instance

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[86] Chadabe, J. (1997) p.291
[87] Borges, J. trans Vázquez, L. (1999).

of performance. According to circuit-bender and performer *Nebula Girl*, "you can try to chart out patterns – I pushed this button, then that button and this happened - but sometimes it doesn't work like that; there's not an 'equation'"[88]. I would speculate that there probably *is* an equation for each effect, but a very complex one depending on ultra-precise timings of connections, which possibly even the original manufacturers would be unable to accurately work out, presuming they had the inclination to do so. As a single action can result in a lengthy (sometimes indefinitely long) sequence being produced, however, the player is permitted some respite during a performance, some time to reflect on which accident to cause next.

These chance occurrences influence the shape the music will take, inspiring the performer to try and 'steer' the music in a specific direction or allowing the device to play out a constantly mutating sequence. This kind of influence has been a recurring theme throughout the history of electronic improvisation as instabilities in the (often experimental or custom-built) technologies have made their presence felt. Rather than attempt to correct these imperfections, many practitioners have welcomed them as unexpected inspirations and influences. Brono Spoerri describes an incident in the 1970s when he performed with analogue synthesisers as follows: "I played on a hot afternoon in open air at the Montreux Jazz Festival and one of my synthesizers started to make strange sounds that it never made before – it was great!"[89], and David Behrman's piece *Runthrough* used a "Lafeyette kit for tremolo. It was supposed to make the sound get louder and softer. But somehow because of some feedback or impedance thing it made it go up and down in pitch, which is sort of an accident and the basis for the 'runthrough' sound'"[90]

On a similar note, in one particular concert my Yamaha keyboard was behaving even less predictably than usual and I was frustrated at my inability to coax the kind of corrupted, aleatoric patterns from the device which I find most interesting. After accepting this inability (it was just 'one of those days'), I gave in and picked the instrument up, having allowed the final sound to die away. The keyboard then started producing another sound – it had initiated a much slower, longer sequence than I had realised. Surprised at this sudden outburst, I glanced at the front control panel of the device and realised that my standard performing position – seated, the keyboard upturned and resting on my lap – had moved one of the sliders out of place, turning the auto-accompaniment feature of the device off and explaining my previous failings. The unexpected operation of the keyboard allowed me to discover and fix the 'problem', providing a very theatrical demonstration of the nature of the instrument and also enabling me to complete the performance in a more satisfactory manner (for me, at least – the audience was divided over which half of the performance they preferred).

Ideas concerning 'coincidence', 'synchronicity', "how we organise the random events we experience into 'models' that give us certainty"[91] are of great importance in my work, regarding both small-scale sonic organisation and wider ranging conceptual frameworks. In terms of the creation and development of objects, software patches

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[88] Sajbel, D. (2004).
[89] Chadabe, J. (1997) p.320.
[90] Holmes, T. (2002) p.229.
[91] Willats, S. (1994).

and ‘finished’ musical pieces, accidents and chance occurrences play a large part in the exploratory trial, error and refining process by which they come about. Accepting and celebrating chance is in some ways a form of collaboration, an acknowledgement that the ‘outside world’ plays a part in the decision-making process. Christian Wolff describes chance as “a way of discovering things, you could call it a heuristic device”[92], and speaking specifically about circuit-bending, Reed Ghazala declares that:

> “The heart of the chance exploration/design process is reflected here. This search, which ultimately does lead to the sound, a destination perhaps, does become more exploration-driven as this process can be just so astounding, suggesting all kinds of controls to integrate into the design of the final instrument along the way. It's exciting.”[93]

It is this excitement, both in the exploration of the unknown and the creation of unexpected connections between pre-existing elements, that I have tried to produce in my work both for the audience and for myself.

The initial ‘sparks’ which set into motion the thought processes and activities leading to the creation of these works are all instances of fortuitous intersections of objects, ideas and contexts. As Richard Arias says,

> “experimental improvised music looks for the unexpected, for unforeseen intersections – ‘we like to remember that for Dionysus (or the Macumba) crossroads are exceptional, almost sacred places’[94] – that may reveal the ‘essential’ as a momentary burst of pleasure.”[95]

While not always relating directly to improvised music, the ‘happy accidents’ and chance discoveries which arise in everyday life have formed the basis for the projects I have undertaken, leading me to draw together disparate threads of meaning, function and situation inspired by a sudden realisation or shift in perspective. In this way

> “Music no longer generates its forms out of itself but out of elements of all systems. music becomes graphic, becomes information, policy makes music, music videos make music, hacking becomes music, etc. Everything works without contamination in the madness of connection between machines, semantics and strategems.”[96]

The eventual finished form a piece takes will always deviate from and expand on this momentary ‘epiphany’ as the process of working through and realisation demanded

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[92] Hamilton, A. (2000).
[93] Ghazala, R.
[94] Barber, L. (1991).
[95] Arias, R. (2002) p.31.

[96] Szepanski, A. (2002) p.227.

by the piece yields new insights and poses new problems, yet the original inspiration for a work still, for me, exerts a considerable influence over its outcome. I realise that this type of discussion could be interpreted as claiming a form of predeterminism, that these events were 'meant to be' rather than occuring purely due to happenstance, but that is not at all my intention. Instead I would simply point out certain concurrent, very ordinary events whose relationship surprised me and provided ideas for a musical work.

With the exception of **duet** (1) and **CD err** (2), the pieces here are named after preset auto-accompaniments found on the Yamaha PSS-380 keyboard employed in **jazz** (7 + 8) – a conceit which connotes their use of 'readymade' objects and allowed me to relate these 'studies' to one another and the concepts they embody. In **blues** (3), for example, the initial catalyst was a semantic one. During a flippant conversation with colleagues, the topic turned to esoteric or obsolete technologies and media formats which could be used for the storage, retrieval and obfuscation of music and / or computer code. After discussing the merits of floppy disks, punch cards and laser discs, bar codes were mentioned. In this particular setting (a *bar*…), in this context (a discussion of music and its *coded* storage), the multiple connotations of the words *bar* and *code* in relation to musical division into *bars*, notation, terminology and programming as *codes* struck me simultaneously - the correlations seemed so obvious and manifold I was amazed they hadn't occurred to me before. The concept of a device which would create musical results from the information stored in bar codes appealed to me on many levels, and it was a short (conceptual) step from there to the connection of a bar code scanner to an electronic keyboard, incorporating the harmonic structure of the twelve bar blues idiom and making reference to twelve tone serialist compositional practice.

As mentioned previously, **tango** (10) was originally intended to make use of the conceptual similarities and actual differences inherent in the sound reproduction mechanisms of a CD player and a turntable. In the process of disassembling a CD player and exposing the mechanical elements necessary for its function, I realised how similar the principle of the system was to the purely mechanical one of the turntable. While I appreciate that this is not in itself a great revelation, and the similarities are not so by chance, this slight change in the way I conceived of the device and the desire to physically demonstrate this mechanical parallel led to the 'final' form of the piece involving two identical CD players linked electronically. These electronic connections actually reinforce the semantic 'tango' connotations, however, as it is the *legs* of the microchips which are intertwined, causing the laser positioning mechanisms to dance.

rickety-tick (5) is one of the stranger names for an auto-accompaniment style available on the Yamaha Portasound PSS-380 keyboard. It was chosen as the title of the piece involving toy piano, tap-dancing samples and a circuit-bent, unstable MIDI sound module as a way to unify the elements through language. I am still unsure as to what style of music this accompaniment was intended to represent, but in addition to being an almost onomatopoeic phoneticisation of the sound made by tap shoes on a wooden floor, 'tick' is also the technical term employed for the smallest unit the MIDI clock uses for timekeeping and sequencing. The concept of a 'rickety' tick, therefore, fitted perfectly with the erratic nature of the sounds produced and the incongruous mixture of wooden and digital technology. The regular, unwavering pulse of 0 and 1 is replaced by a crude, creaky mechanism.

The idea for the mechanical slide guitar employed in **hawaiian** (6) developed from two different directions. The mechanical elements found inside a CD player suggested one half, as the 'slide' mechanism is simply a laser-positioning sled removed from a CD walkman and repurposed as a way of moving a metal slide along the guitar string instead of a laser beam across the surface of a CD. The second aspect, the motorised 'plucking' arm powered by the computer's USB port, arose from a particular shopping experience I had. Whilst purchasing some 'phono' audio connectors in an electronics store for use in a project, I noticed for the first time that in the shop's 'audio connectors' section, in addition to the regular jack, phono, XLR and banana plugs and sockets, individual USB plugs had been added to the available components. This surprised me, as I had not expected USB parts to be contained within the 'audio' section of the shop, and this unexpected categorisation made me rethink my preconceptions of the technology and led to thoughts of ways I might utilise it for musical purposes. Initial experiments with a music box and motor[97] proved that it was very easy to draw power from the USB port, and this principle became the one eventually used in **hawaiian** (6).

From a similar perspective the specific combinations and arrangements of elements used and in these pieces are also arrived at largely through chance rather than design. In **blues** (3), for instance, I was interested in attempting to connect a barcode scanner to an electronic sound-making device, but with regard to the precise make, model or type of each I had no real preconceptions or foreknowledge about which particular combination would produce the best results. The eventual choice of components was a purely pragmatic one (as many of my decisions are) – the barcode reader 'game' used was the cheapest variety I could find, a precaution in case the device broke or failed to yield interesting results, and the keyboard was one donated to me by a colleague who had no further use for it. Similarly, the first CD player I modified (a Sony D-121) was chosen because it was the cheapest second-hand model I could find. Having eventually discovered through trial and error, using chance as a 'heuristic device', certain desirable and useful modifications this became my model of choice. In later discussions with Nic Collins I discovered that certain of these modifications which had played a large role in forming the identities of pieces, such as the ability to replay a CD at half-speed, were unique to this particular make and model. Had I chosen any other device, or gone into the shop on a different day, the results may have been very different. The connections, relationships and effects possible with these particular models will undoubtedly differ from those which would be offered by alternative devices, and so the ultimate realisation of the work is shaped by the chance contiguity of these systems.

The relative ease with which these two distinct, unrelated systems and the others described elsewhere could be conjoined is also an issue relating to 'precision' and 'chance'. The growing standardisation of electronic and mechanical components in terms of technical specifications and physical dimensions has allowed for elements to be replaced, exchanged and connected in myriad ways unforeseen by their makers. The new system structures brought about by these connections are reflected in the

[97] Fig. 9.

structures of the music produced, created by the chance collision of multiple objects and contexts. In a working methodology concerned inherently with technology, the artist Paul DeMarinis asserts that:

> "[A]rt is a response to belief and acts as a consolidating force within culture. It gives place, time, image, and sound to myths. But the myths of science are not content to be represented by picture, poems and symphonies. The scientific revolution threw away the idea that things were connected by appearances and replaced it with the idea that things are connected by how they work. Thus the artist's role is to animate with the imagination the way things work."[98]

These explorations of things 'connected by how they work' both in literal, technical terms and in terms of their functions and positions in the world form the basis of these pieces and also, through the chance interactions of precise systems, form the structures of the musical works.

[98] Shiba, S. (1997).

Expertise / Inexpertise

> "Music has lost its power. So has visual art, so has prose. Now it is the sole responsibility of the writers of limericks to describe the human condition" (David Shrigley)[99]

This is, in many ways, the most problematic section of this document. How can one take a position in defense of 'inexpertise' in the context of the results of long-term scholarly research? The answer is that in most cases I am not, and the expression is used as a shorthand, an umbrella term under which other issues can be discussed. But only in most cases.

The objects employed in these studies are not professional audio devices. The Casio corporation, for instance, sold most of their instruments through department stores, placing them "outside the mainstream music retail and distribution network. Because of this distribution method and because of its reputation as a supplier of consumer (i.e., hobbyist) musical instruments, only a handful of Casio products ever gained acceptance in the professional and semi-professional musicians' market."[100]

This location of the electronic keyboard as a 'hobbyist' instrument contrasts with the historical position of its predecessors.

> "[T]hroughout most of their history, keyboard instruments have generally been the province of the middle and upper classes. Compared to other instruments they are relatively expensive, they need to be kept indoors, they must be regularly tuned and serviced by trained technicians, and playing even a simple accompaniment on them might demand considerably more study than is required on an instrument such as the guitar."[101]

A class of instrument which was once expensive and needed regular servicing is now amongst the most inexpensive and widespread. Children start their musical education on electronic keyboards where their inexpertise can be silenced with headphones, 'graduating' to the piano, a 'real' instrument, if they show sufficient commitment and talent.

The relative difficulty of 'playing even a simple accompaniment' on an acoustic piano is rendered effortless by the range of 'auto-accompaniments' built into the domestic consumer keyboard. The ultimate distillation of genre-division, this facility boils down musics which are radically divergent stylistically, historically and culturally into a homogeneous array of four-bar repetitions, able to be recalled and replayed in any key or tempo. This flattening of diversity becomes the starting point of **jazz** (7 + 8)

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[99] Shrigley, D. (2002).
[100] Théberge, P. (1997) p.74.
[101] Ibid. P. 173.

– in place of pre-existing popular songs or folk melodies, the basis of extemporisation and improvisation in this performance becomes the preset patterns and sequences built into the keyboard. As the signal paths become rearranged and corrupted, a sort of 'genre-splicing' takes place whereby these essential, reductionist representations of stylistic characteristics mutate and combine to form new streams of material. At once familiar and alien, these results refer to childhood memories of hearing the 'demonstration' song of an electronic keyboard play again and again - but this time instead of repeating an identical musical sequence, it plays its 'own music', inherent in previously unrealised electronic connections.

Musicians such as John Cage, David Behrman, Reed Ghazala and other circuit-benders have used such 'toy' instruments to both exploit the "ambiguously disturbing yet comic implications"[102] of recontextualised toys and distance their activities from traditional musical thought. As Stuart Jones asserts:

> "Conventional music making, whatever the genre, is rooted in a stringent technical discipline: hours of practice honing instrumental skills, perfecting technique. This can, of course, be liberating, but it guides creativity down certain paths, and sometimes it is useful and necessary to get away from those paths."[103]

The conventional model of musical progression dictates that one must invest as much time into practicing and as much money into obtaining the best instrument (or equipment, software) as possible, the more of each spent, the better the chances of becoming a 'good musician'. The two go hand in hand – extensive practice with an inadequate instrument can only get you so far as will inexperience and a high-quality instrument. This type of 'expertise' is, of course, only one possible route – albeit one which allows for a system of increasingly expensive commodities to be produced and for levels of progression 'up the ladder' to be consistently and easily assessed. By utilising cheap, 'toy' instruments and other 'non-musical', consumer devices with their inherent 'inadequacies' in terms of the standards of this system, musicians have managed to exploit and celebrate the qualities of the devices themselves and at the same time critique the values of the dominant culture. Australian composer Ross Bolleter's 1990 piece *Nallan Void*, for instance, is "a conventional parlour piece, except that it specifies the use of an out of tune 'ruined piano prepared by its environment' at an outback sheep station"[104] – a piece which subverts not only the 'increased musicality' of high-quality instruments, but also John Cage's own meticulously prepared piano pieces, as the 'preparations' lie outside the composer's control and "a different ruined piano would give a completely different result."[105] Musicians who make use of toy pianos (John Cage, Margaret Leng Tan[106]), electronic toys (The Modified Toy Orchestra, Mutant Data Orchestra), even vegetables (The First Viennese Vegetable Orchestra[107]), show that these are not 'lesser' or 'non' musical objects, but simply *differently* musical. Their inability to be fitted into what

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102 Toop, D. (2003) p.119.
103 Jones, S. (2001) p.63.
104 Hamilton, A. (2003) p.219.
105 Ibid.
106 http://home.earthlink.net/~margaretlengtan/
107 http://www.gemueseorchester.org/

has become the conventional musical schema is not a failing, instead their unique, individual characteristics become defining features of their own music.

The utilisation of 'toy' instruments – toy piano, toy accordion, toy guitar – and consumer, amateur equipment is on one level an explicit manifestation of the playfulness with which technology is approached and employed in the works presented here. Alan Rath asserts that when dealing with technologies "our problem is not getting their experiential or toy possibilities. Play is one of the most significant human activities and machines help us play."[108] The predominance of electronic toys in the works of circuit-benders (myself included) reflects this attitude, along with more pragmatic incentives such as their cheapness and relative simplicity of operation. The appeal of creating 'something from nothing' is also undeniable, or as Chachi Jones puts it, turning "thrift store toys into magically glitchy musical instruments"[109]. He continues, however, to claim:

> "[T]his generation is particularly reluctant to acknowledge the phenomena, possibly because many of the toys that are subject to the transformation — like the Speak & Spell, Casio SK-1, Touch & Tell — still have this aura of childhood futurism. It's as if admitting that these toys are obsolete is to admit that the promise that they held for us in childhood is no longer relevant today."[110]

As implied above, I would contend that rather than admitting obsolescence, this approach is actually a further fulfillment of the promise of childhood toys concerning play and imaginative exploration.

The devices mentioned above - Speak & Spell, Casio SK-1, Touch & Tell – and the ones primarily used in my works such as the Yamaha keyboards, early Sony Discman and inkjet printer, date from the late 1980s to the early 1990s, a period of the recent past which is 'known', discarded - too old to be new and too new to be old. I believe, however, that the use and recontextualisation of such devices is a different activity to previous recent technological 'retro revivals'. As Jones stated above, 'this generation' (of which I would call myself a member) has a particular relationship with the time period which colours the way it and artifacts from it are perceived, but there is still a kind of 'limbo' in which these objects exist. The process of 'revival' has commenced recycling objects and fashions from the 1980s, and just as valve amps and analogue synthesisers from the 1960s and 1970s were reevaluated and claims made for their superiority to later equipment, in pop music the same is happening with an upsurge in electro and post-punk stylings. I have not witnessed a similar influence in academia at the time of writing, and while this may only be a matter of time, I think the technologies involved are a prohibiting factor. It may be that this past is simply currently too recent to reevaluate in such a way, but barring a radical change in current technology to make the sound of early digital synthesis remarkable again, it seems improbable to me that the relatively short time separating the obsolescence and subsequent 'rediscovery' of valve amps and analogue synthesisers will be repeated with, for instance, the Yamaha DX-7. A further factor is one already mentioned:

[108] Tromble, M. (1998).
[109] Weidenbaum, M. (2004).
[110] Ibid.

unlike such ‘revived’ technology from previous decades, these devices were not professional quality products, they were intended for use by children, amateurs, hobbyists – *they were never meant to be any good in the first place*. This, of course, makes the prospect of ‘rehabilitating’ such objects and using them to produce something meaningful and worthwhile even more attractive. Furthermore, in contrast to the previously mentioned ‘revived’ technologies, many of these objects, whilst sound-producing in some way or another, are not designed to be ‘musical’ objects. The re-use and re-purposing of devices such as dot-matrix printers and electronic games adds a further dimension to the distinction – it is a *technological* sampling and recontextualisation, not simply a *musical* one.

In a discussion with David Behrman, Ron Kuivila suggests that:

> “[T]he ephemerality of technology is two-fold – a technology can become unavailable or just horribly banal...[An] effective approach is to use totally digested technologies, those that are out of date or so commonplace as to be banal. The machines are cheaper, more accessible, easier to manipulate and often carry much greater social resonance than ‘high-tech’ equipment”[111]

Ease of manipulation is an issue of great importance in this type of working methodology. The devices produced in the late 1980s and early 1990s offer relatively sophisticated synthesis and sampling capabilities from components which are large and discrete enough to physically access and modify. More recent electronic devices present tougher challenges to the would-be modifier in the form of miniaturised circuits and ‘all-in-one’ microchips, making the location and fixing of new connections more difficult.

So far non-professional, consumer technology has been examined in terms of its possible applications to music-making, but I will also try to argue for the creative validity of certain types of human inexpertise – that it is not always necessary to be knowledgeable, and sometimes it can pay not to be. The two ends of these continua of technological and human ‘expertise’, are represented in **boogie woogie** (4) where recordings of ‘real’ acoustic piano sounds are combined with the consumer electronics of the Casio corporation’s SK-5 keyboard. The interventions made in the operation of the CD players used to replay the recordings alter their nature, cutting sounds off prematurely and repeating tiny fragments, which, combined with the glitches produced by the devices creates a sharp, percussive stream of material. This reflects the “extremely percussive style”[112] in which the early blues and boogie woogie pianists played, and

> “at least one historian has suggested that this style might not have been simply the result of musical predilection. In her book *The Jazz Scene*, E. J. Hobsbawm has stated that most of the boogie woogie pianists were ‘limited’ at best, and, even among the most expressive players, some were technically ‘downright bad’(1989: 120)”[113]

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[111] Kuivila, R. and Behrman, D. (1998) pp.13-14.
[112] Théberge, P. (1997) P.173.
[113] Hobsbawm, E. (1989) quoted in Théberge, P. (1997) P.173.

The technical inexpertise of these players therefore helped to define the characteristic sound which came to distinguish the genre, while the performer's actions in this piece consist of simple, everyday gestures – operating the standard controls of the CD players - actions of comparative non-proficiency.

As pointed out by Bob Ostertag, "Virtuosity has been out of fashion for years now, ever since the advent of punk rock, conceptual art and other movements that emphasize the idea rather than its execution"[114] and like peering through a keyhole, lack of knowledge or familiarity can induce a skewing of perspective and emphasise features normally considered irrelevant. The Portsmouth Sinfonia's desecration of popular classics by 'expert' musicians such as Gavin Bryars and Michael Nyman playing instruments they couldn't, Mauricio Kagel's *Exotica* in which "performers have to try to master the techniques of the non-Western instruments as best they can"[115], and groups such as Deerhoof, Maher Shalal Hash Baz and their spiritual godmothers The Shaggs' deconstructions of popular music by a willful refusal to learn to (or a naïve unawareness that they do not already) play 'properly' – all speak volumes about the nature of music. Hearing a familiar piece or style of music 'break down' in this way can be a very effective way of achieving the effects of defamiliarisation discussed previously. When the Portsmouth Sinfonia plays Tchaikovsky it is heard with a renewed freshness - it is (sometimes literally) a different piece to the one ingrained in the collective consciousness. What was once a cohesive whole becomes a blurring of individual, simultaneous lines, exposed by errors in pitch or timing - the actual construction of the piece, and of the orchestra is uncovered by its heterophony.

Similarly with The Shaggs' ramshackle bubblegum pop, the raw elements of popular song are skewed and diffused. Lyrics covering the typical preoccupations of teenage girls – boys, cars, parents, music – are sung in a deadpan monotone whilst the only common factor shared by the amateurish guitars, bass and drums is that they happen to play at the same time. The arhythmic rhythm section, out-of-tune guitar and unscannable (but quite catchy) vocal lines coalesce at certain points at the beginnings of sections, or take turns dropping in and out, and this is just enough to maintain their recognisability as songs. By reducing the component elements of girl-group rock n' roll to ultra-basic tropes – it doesn't matter if the drums are out of time with the other instruments, as long as there *are* some drums – the communication of their understanding of conventional songwriting (unwittingly) deconstructs the whole activity in a unique and personal manner. This sense of 'decomposition' is one I have tried to replicate in pieces such as **duet** (1), **rickety-tick** (5) and **hawaiian** (6) – revealing the forces and organisational strategies involved in the work through their continual breakdown and recombination.

When approaching an unfamiliar system, discipline or doctrine without any prior knowledge, the sets of understanding we have developed and accumulated for successfully dealing with other situations and schema are brought to bear. Ways of thinking about and conceiving of things are translated and transposed onto unfamiliar experiences. In this way such traditions as the 'art school' band – people with little or

[114] Ostertag, B. (2002) p.11.
[115] Hamilton, A. (2003) p.218.

no formal musical training but who ‘do’ music in a ‘visual art way’ – can manifest unusual approaches and attitudes towards music, as opposed to singular ‘correct’ or ‘normal’ interpretations.

An amateur guitarist playing along to a record in an attempt to learn a song can ‘get it wrong’, but prefer the riff generated by her accidental wrong note, leading to the creation of a completely new piece. The original catalyst for this new masterpiece is discarded, its ‘truth’ is only temporary – an understanding of a system, a work, a technique, is only ‘true’ as long as it is useful. Mappings from one or more sets of understanding onto the formulation of another may be useful for creative activity whether or not they coincide with the ‘real’ way things work. My ‘knowledge’ of electronics, for instance, is the result of a tiny amount of research into the function of certain basic components and a large amount of trial and error experimentation. This approach has proved useful in several cases. When realising **tango** (10), for instance, my inexpertise and unsurety made the final piece possible. During my initial modifications of the CD players, had I been more knowledgeable I would have ‘ripped the pin off the chip’ in the way Nic Collins described earlier. As it was, I was forced to be more cautious and merely levered the pin up off the circuit-board, allowing for its use in the system employed in the piece.

Through this process I have established an ever developing ‘understanding’ of electronics, arrived at ‘my way’, which allows me to work with and negotiate the technology in the ways I need to in order to achieve results in an individual, personal way. Again, this understanding - ‘doing’ electronics in a ‘musical way’ - may or may not overlap with the genuine laws of electronics, but in several circumstances, despite of or because of my lack of knowledge, it has permitted me to produce outcomes which surprised colleagues with much greater experience of electrical engineering.

In the early days of electronic music, practitioners had to be familiar with the principles of electronics in order to produce their own sound-making circuits. Alvin Lucier, David Tudor, David Behrman *et al* had or developed a background in electronics. To be able to utilise cheap components and work without the aid of technicians they *had* to have this knowledge, and it informed the way in which they worked with electronics and how they designed and built the circuits they did. This knowledge enabled them to build streamlined, efficient, elegant circuits which made the most of the materials available. Now, thanks to their efforts, we can buy sound-producing circuits from second-hand shops which are so far beyond anything a home-electronics enthusiast could put together and disposably cheap, that there is no need to build one’s own oscillators or filters. Thus the knowledge of how to do so is no longer relevant or necessary, and therefore does not inform the subsequent working method. Efficiency, elegance, forethought, design are no longer crucial virtues when working with technology. I also do not conceive of my relationship with music (or the world in general) along elegant, clean, efficient lines. Rather, I prefer to work with messy, disorderly, fragile objects and concepts which both coincide with and disrupt each other.

As discussed previously, ‘defamiliarisation’ is a common tactic for creative artists trying to escape familiar habits and working practices, destabilising their relationships with tools, concepts or techniques they have grown too accustomed to. The desire to return to a ‘state of innocence’, to un-learn received ideas and explore afresh, is one found continually in creative discourse. Whilst this mythical condition is different in kind to actually *being* inexperienced, inexpert, learning and discovering things for the first time, they are both aspirational states – one trying to develop an understanding of something, the other trying to un-understand it. This is where I would contend the most interesting artistic work is produced. Not in the middle-ground of 'competency' (the ultimate damnation of faint praise), in the comfortable reliance of well-worn strategies, but in a personal discovery or rediscovery of materials.

Recalling Kagel's *Exotica* mentioned earlier, Nic Collins describes the sound of someone approaching an unfamiliar instrument for the first time as "the only authentic sound we have left."[116] In an age in which anything can be replicated, simulated and faked, the sound of inexpertise, of exploration is the only remaining 'reality'.

This acceptance of 'errors' and appropriation of accidents is becoming ever more widespread in electronic music, and has even spawned a subgenre – 'glitch' – based around "the aesthetics of failure"[117]. Whilst this genre preoccupies itself with the *sounds* of imperfection – the clicks, pops and ticks of digital sound – often structured and arranged in fairly conventional manners, I have been more interested in creating structures derived from these factors. **rickety-tick** (5), for instance, embraces a wider category of 'sonic detritus' than is found in much 'glitch' music. The sound sources involved – toy piano, circuit-bent General MIDI sound module and tap-dancing samples can (deliberately) recall the 'clicks and cuts' glitch aesthetic at times, but instead of consisting purely of typically discarded microscopic sound fragments, the detritus is cultural rather than sonic. Toy instruments, *ersatz* MIDI substitutes and tap dancing – 'non-serious' musical sources combined in a network of mis-translation and coincidence.

Thus far I have avoided discussing my work in terms of superficially obvious terms such as 'malfunction' and 'error'. When dealing with technology, the issue of what constitutes an 'error', and particularly a 'machine error' becomes highly problematic. With David Behrman's piece *Runthrough* discussed previously, for instance, in which the sound character came about "largely due to imperfections in an off-the-shelf electronics kit that he used to build one of the key circuits"[118] the components did not behave as expected, but whether this is a malfunction or not is debatable. A similar effect is used in **rickety-tick** (5) and **hawaiian** (6), both of which make use of a 'frequency-detection' software object included in the *Supercollider* programming language and the anomalous output it produces when dealing with complex sounds. Initially this could be seen as a 'computer error' – the software has detected the pitch incorrectly – but in reality the code is working absolutely as it was intended to, and the only erroneous element is the claim made for the properties of the code, or more likely the expectations held by the user. This is not a 'malfunction', then, simply a limitation of the code or a misuse of its function – the failing is a human one if there is one at all. As all machines are by default man-made, any unwanted operation can be seen as a human error rather than as a malfunction of the machine, or as a flawed perception of how the device should work, "reminding us that our control of

116 Collins, N. In conversation with the author Jan 22nd 2004.
117 Cascone, K. (2000) p.12.
118 Holmes, T. (2002) p.228.

technology is an illusion, and revealing digital tools to be only as perfect, precise and efficient as the humans who build them"[119]. The deliberate overloading of the CPU in **hawaiian** (6) and of the 'error-correction' circuit in a CD player in several pieces discussed earlier are possible exceptions, as the very presence of an 'error-correction' system admits the existence of errors, but even these are open to debate. The principles on which I have based my work, then, are not those of 'error' and 'malfunction' but of (mis-)translation, (mis-)mapping and difference of operation through which previously unimagined results can emerge.

Deliberate mistranslation and misappropriation can be useful tools for creative activity and for developing new understandings. My initial fascination with Japanese music and culture arose not from a sense of exoticism, a wonder at how different it was from my own, but how close in many ways it was while seeming to absorb and refract Western culture in a completely unfamiliar way. The importation of contemporary 'cultural products' (e.g. music) has occurred only relatively recently in Japan following long periods of isolation, and mainly during the 'bubble economy' when the exchange rate provided favourable exchange rates for importation, which imbues them with an aura of both novelty and ahistoricity. At the same time, the phenomenon of 'reverse-import' (*gyaku*-import) means that "Japanese artists will have little chance of success without first exporting their art to foreign lands. Then, their art can be re-imported to Japan with the aura of a foreign product."[120] This explains both the heavily Westernised sound of artists such as Pizzicato 5, Cornelius and Melt-Banana as well as the skewed take on Western culture displayed in their image and music. Commenting on *Maywa Denki*'s Satoru Ono drawing of parallels between his own techniques and those of Stockhausen, Emmanuelle Loubet describes "a hasty comparison that always leads one to ask on what informational sources these comments are based. For instance, Stockhausen is often cited by Japanese musicians as a symbol of both computer music and *musique concrète*."[121]

Forgetting for a moment the received wisdom concerning the influence of *Hymnen*, in terms of creative inspiration it makes no odds whether there really was a figure named Stockhausen who exists as 'a symbol of both computer music and *musique concrète*' as long as the idea of his existence elicits a useful response. Cultural goods are merely commodities, ones which "assume the function of icons – emblems drawing disparate groups closer together. Records are not made to be listened to, but to create points of intersection between the formation of cultural islands."[122] Experiencing my own culture devoid of its familiar 'cultural baggage' made me re-examine assumptions I had held unthinkingly, and opened up possibilities of thought impossible without this flattening of historicity and value.

Taking this cultural 'exoticism' to unparalleled lengths has resulted in a sophisticated strategy of willful mis-translation and mis-appropriation. Realising the certain naïve appeal that mistranslation can afford, the Japanese have developed a stylised approach to the English language (*Engrish*) which deliberately plays with differences, prior misunderstandings and differences between the two languages and cultures. This

[119] Cascone, K. (2000) p.13.
[120] Loubet, E. (2000) p20.
[121] Ibid p28.
[122] Loubet, E. (2000) p.19.

remarkable strategy reveals nuances and idiosyncracies in both Japanese and English (we unthinkingly accept a Japanese computer game called *Donkey Kong* featuring a giant monkey), and is a model I have tried to apply in my workings with technology and music.

I realised early on in my musical education that I had neither the aptitude nor the inclination to become a performer. I was happier 'playing' than performing - improvising, experimenting and composing rather than learning other people's music. To this end, working with live electronic music, I have developed strategies and machines which while incorporating a human performer (myself) place this performer on the margins. In all the pieces I have presented, there is little or no call for the performer to display virtuosic abilities, instead the devices themselves form the centre of the experience. Rather than saying 'look at me', the performer says 'look at this' – he assumes a position not dissimilar to that of the audience, surprised at and responsive to the sounds of the circuits.

The once academic, institutional nature of electronic music is now a thing of the past, or at least now only one facet of its identity. The requisite technologies are now commonplace, and the levels of knowledge and skill needed to use them both much lower and more widespread. Despite the disparity in the technologies employed, there are now those who view certain practices of electronic music making as being a form of folk-art. DJ Spooky, for example, suggests that:

> "Electronic music is, in a way, the folk music of the 21st century. Instead of, say, the '20s, where you had everyone who knew a blues riff playing a guitar, you now have everyone who knows certain beats and things like that putting them together and then circulating them."[123]

While this approach focuses on a shared 'musical' knowledge, a more interesting approach concentrating on technological and sociological factors is taken by Chachi Jones and other circuit-benders regarding their practices. Comparing electronic hardware modification to the appropriation of everyday items in folk-music making he declares that

> "to make music with jugs, musical saws and washboards is an instinct that takes the abundant, inexpensive artifacts from your life and transforms them into something roughly musical… [I]f you think about why those instruments came about, it's because people back then had jugs and saws around the house, or birch trees they could carve fiddles from - again, it's taking what's around us and abundant and recycling it into art. Today we don't have extra trees to chop down or storage jugs lying around, but we do have piles of obsolete technology one step away from landfill that we can't even give away. In that context, taking a 1980s toy keyboard you found in a thrift store dollar bin, and rewiring it to make outrageous, unintended musical noises, is really a textbook example of a folk

[123] Holmes, T. (2002) p.271.

> instrument - as much or more so than hip-hop's assertion that turntables are a folk instrument."[124]

The skill-sets needed for this type of activity are similarly easy to acquire. Soldering is learnt at school, at work, or can be picked up in a matter of hours or even minutes. As proven earlier, only the most basic knowledge of electronics is necessary to successfully modify a device, knowledge which again will have been gathered within the course of daily life or which can be attained quickly and easily. These everyday, commonplace connotations are carried into performance, where the normally mundane, domestic activities of playing with a toy or printing a page of text become public, music-making ones. The barcode scanner interface utilised in **blues** (3) appealed on this level – the action of swiping a barcode through a scanner can never become virtuosic. It carries connotations of monotony, repetition, security, commerce (the slogan of the 'barcode battler' game used is, appropriately enough, 'commerce conflict') but not creativity or performance. It is a manifestation of the suggestion that any action, any object can be musical, as well as a comment on the multiple codifications, commodifications and methods of storage associated with music – realised with no specialist knowledge and requiring no training to operate. If less time, money and resources are needed in such a methodology, more can be diverted to playing (in all senses of the word), listening, thinking about *why* rather than *how* – all activities I consider valuable.

Ironically, the development of these approaches – celebrating amateurishness, partial knowledge, deliberate mistranslations and inexpertise – leads to what can be seen as another form of expertise. Becoming expert in avoiding expertise, virtuosic at anti-virtuosity is simply another strategy to find personal methods of creativity and expression.

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[124] Weidenbaum, M. (2004)

Conclusion

The intention of this document has been to support and contextualise the artistic work produced and presented, situating it in terms of the methodologies, ideologies and technologies employed in relation to contemporary thought. The work of other artists and theorists has been examined and connections drawn between a variety of approaches, concepts and working practices.

The work has been discussed in relation to five sets of contrasting dualisms pertaining to issues surrounding the pieces, and a multi-angled approach to examination was adopted to convey and explicate their 'messy', 'coincidental' nature. The sets of concepts used offer dualities which can be seen to represent generally asymetrically privileged issues relating to music-making, technology, and the creative process with the first in each pair – composition, design, digital, precision, expertise – commonly deemed to carry more worth than the second – improvisation, modification, mechanical, chance, inexpertise. These assumptions have been unpacked and critically examined, their use as meaningful creative forces approached in a personal manner.

Composition and improvisation have been shown to share many salient features, each capable of informing and influencing the other. The varied applications of both composition and improvisation in my work have been discussed to illustrate this two-way relationship, specifically grounded in my working methodology. An approach combining design and modification of hardware, software and sound has been put forward which acknowledges the influence of technology on the creative process and explores ways in which this might be addressed. The combination of mechanical and digital technologies in my own work and in the work of other artists has been investigated along with the connotations which accompany them, and objects have been created and examined in terms of the ways in which they relate to these connotations. The roles of both precision and chance factors in music-making have also been discussed and the usefulness of 'accidents' as means of discovery suggested. Similarly, certain forms of inexpertise and the attitudes they engender have been held up as potentially fruitful approaches when dealing with music and technology in these ways. The use of automata, pre-existing, readymade objects which produce sounds and structures from their inherent workings and cultural perception rejects

> "minimalism, which processes the inner life of sounds and music objects… in favour of a super contextualisation, in favour of the production of polyvalent structures."[125]

It reveals 'composition' to be

[125] Szepanski, A. (2002) p.228.

> "…the realisation of a network of interactive processes that engender other, equally interactive processes such that the musician is just a link in the chain of processes."[126]

What has been created, therefore, are compositions for improvised objects, devices designed to improvise with modified compositions. A precise balance 'between nothing and random' creates structures of accident and coincidence, entirely consistent with the way the works were conceived of and created. Digital and mechanistic technologies and connotations collide in 'electro-mechanical limericks', celebrating mistakes and inexpertise, and suggesting alternative possibilities for personal engagement with technologies. Various concepts and instances of technology have been 'played with', exploring particular human-machine relationships in a musical framework.

> "We might not be able to *perform* with machines, but we can *play* with them, which may be the best thing humans can do with them at this moment of history. Negotiating this terrain, however, requires that artists who use machines must do so critically: not celebrating technology but questioning it and probing it, examining its problematic nature, illuminating or clarifying tensions between technology and the body, and thus offering the kinds of insights only art can provide…"[127]

What is presented here, then, is not a collection of new 'instruments', physical or software, rather manifestations of different ways of *conceiving* of existing technology, suggestions of different possible relationships we might adopt which could result in useful, meaningful and *individual* creative responses.

[126] Chadabe, J. (1997) p.294.
[127] Ostertag, B. (2002) p.14.

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Appendix 1

Duet Code

```
-- instant electroacoustic duet

-- (c) phil archer 2000
-- processes live input + follows 'scores' stored as tables:
-- gdur1 = Grain Duration
-- gden1 = Grain Density
-- tdis1 = Time Dispersion
-- pdis1 = Pitch Dispersion
-- gamp1 = Grain Amplitude
-- pch2 = Pitch2
-- tim2 = Time Rate2
-- sampchance = chance of recording input to audiobuffer for processing by
graininstr1
-- length = graph to show time elapsed

-- 2 processes:
--
-- 1) realtime delay line based granulation
--    plays chunks from its 'memory' as you play

-- 2) sampling based pitch+time change looper
--    randomly (based on current value of 'sampchance') records live input into
--    an audiobuffer for looped pitch+time changing

--  N.B. sometimes (don't know why) when patch is run sound is choppy + fuzzy.
--  Halt patch + then start it again til it works.



defaudioin Lin Rin;
defaudioout L R;
defdelay dlyL(20.2) dlyR(20.2);
deftable gdur1, gden1, tdis1, pdis1, gamp1, pch2, tim2, sampchance, length, mad;
var altime = 330;
defaudiobuf audiobuf1;

init {

    allocAudio(audiobuf1, 400000);
}

start {
```

```
    dgrain.value;
    dorecord.value;
    graininstr1.value;

    {

        in(Lin).out(dlyL);
        in(Rin).out(dlyR);
        in(Lin).out(L);
        in(Rin).out(R);
     }.dspAdd(0);
}


dgrain {

    rtime = altime;
    pitch = (1.getItemValue);

    --pitch score

    pscore = Ptransient(pdis1, rtime, 1, 1,    );

    dur = 2.getItemValue;

    --duration score

    duscore = Ptransient(gdur1, rtime, 1, 1,    );

    --density score

    descore = Ptransient(gden1, rtime, 1, 1,    );

    --time dispersion score

    tscore = Ptransient(tdis1, rtime, 1, 1,    );

    --amp score

    ascore = Ptransient(gamp1, rtime, 1, 1,    );
    mscore = Ptransient(mad, rtime, 1, 1,    );


    ^{

    base = 1.3 + (4.getItemValue.rand2).round(4);

    rnd = rand(100);
    if rnd > 75.0 then
    pitch = pitch + (5.getItemValue.rand2 / 2);
```

```
    1.setItemValue(pitch);
    end.if
    if rnd < 10 then
    pitch = 1;
    1.setItemValue(pitch);
    end.if

        2.setItemValue(duscore.value - 1);
        3.setItemValue(descore.value - 1);
        4.setItemValue(tscore.value - 1);
        6.setItemValue(ascore.value - 1);
        5.setItemValue(pscore.value - 1);
        21.setItemValue(mscore.value - 1);

        if 21.getItemValue < 0.1 then
        madness = 0;
        madness2 = 0;
        else madness = (dur * (21.getItemValue - pitch)).rand2, madness2 = (dur *
(21.getItemValue).rand2)
        end.if;


        rampenv = Aline(base + (madness2 ** 2.5), base + (dur * (1.0 - pitch)) -
madness, dur, `dspRemove);

        ampenv = Aparenv(dur, (6.getItemValue + 0.35), );
       {


        dtime = rampenv.value;
        zamp = ampenv.value;
         (tapi(dlyL, dtime) *! zamp).out(L);
        (tapi(dlyR, dtime) *! zamp).out(R); }.dspAdd(1);
        [dur / 3.getItemValue, thisFunc].sched;
    }

}


dorecord {
        stime = altime;
        sampyes = Ptransient(sampchance, stime, 1, 1,     );

    ^{

        rnd = rand((250.0 - sampyes.value));
        17.setItemValue(0);
        if rnd < sampyes.value then
        17.setItemValue(1);
```

```
        purgeAudio(audiobuf1, 400000);
        allocAudio(audiobuf1, 400000);
        samp1 = Arecord(audiobuf1, { dspRemove; });



        {  samp1.value(in(Rin));
        }.dspAdd(0);

        end.if


        [1.0, thisFunc].sched;
        }
}

graininstr1 {
   -- declare variables:
   tpos = 0.0;
   deltat = dur = 2.0 ** 5 * 0.001;
   overlap = 0.5;
   dtime = altime;
   tscore = Ptransient(tim2, dtime, 1, 1,    );
                  pscore = Ptransient(pch2, dtime, 1, 1,    );
   totlength = Ptransient(length, dtime, 1, 1,    );

   -- define and return instrument function:
   ^{

      18.setItemValue2(totlength.value);
      22.setItemString(totlength.value);



 -- time parameters:

        14.setItemValue(tscore.value - 1);

        if tpos >= 4.0 then
        tpos = 0.0;
        end.if

        tpos = tpos + (2.0 ** 14.getItemValue * deltat);

        -- pitch parameters:

        13.setItemValue(pscore.value - 1);
        pch = 13.getItemValue ;
```

```
        -- amplitude:
        amp = 0.4;

        -- allocate grain function
        grain = Acpgrain(audiobuf1, tpos, pch, dur, amp, `dspRemove);

        -- define dsp function
        { grain.value.out(L).out(R); }.dspAdd(1);

        -- schedule next grain:
        overlap = (0.5 ** 0.5);
        nextdur = (2.0 ** 5 * 0.001);
        dt1 = nextdur * (overlap - 1.0) + dur;
        dt2 = dur * overlap;
        deltat = (dt1 max:dt2);
        [deltat, thisFunc].sched;


    }
}
```

Boogie Woogie Code

```
// 2 streams of sound
//plays one normally until
//button is pressed then time-stretches sound + switches to 2nd sound

var filename, sound, signal;
var go, s1x, s2x, in1, in1fx, in2, in2fx;
var offset1, spd1;
var looplen = 0.005, xfadelen = 0.0025, env;
var recbuf1, slowdown1, gonow, crunch, pat, r, t, q, srate, sspd;
var inchange, sound1, sound2, sound3, in3, out, trate;
var recOn, recStart, rstart, amp, threshhold, trigger, trigger2;
var slow1, slow2, slow3, slow4, slow5, slow6, slow7, slow8, slow9, slow10;
var fast1, fast2, fast3, fast4, sf1, sf2, sf3, sf4;
var slow1x, slow2x, slow3x, slow4x, slow5x, slow6x, slow7x, slow8x, slow9x,
slow10x, slow0x;
var fast1x, fast2x, fast3x, fast4x, fast0x;
var slowout, fastout, tgo, tgo2;
		var w;
	w = GUIWindow.new("panel", Rect.newBy(128, 64, 400, 400));
	ButtonView.new( w, Rect.newBy(9, 371, 128, 20), "GO! NOW!", 0, 0, 1, 0,
'linear');
	NumericalView.new( w, Rect.newBy(10, 16, 64, 20), "NumericalView", -1, -
1e+10, 1e+10, 0, 'linear');
	NumericalView.new( w, Rect.newBy(246, 16, 64, 20), "NumericalView", 0, -
1e+10, 1e+10, 0, 'linear');
	CheckBoxView.new( w, Rect.newBy(9, 46, 128, 20), "sound1", 0, 0, 1, 0,
'linear');
	CheckBoxView.new( w, Rect.newBy(9, 70, 128, 20), "sound2", 0, 0, 1, 0,
'linear');
	CheckBoxView.new( w, Rect.newBy(9, 94, 128, 20), "sound3", 0, 0, 1, 0,
'linear');
	NumericalView.new( w, Rect.newBy(252, 371, 64, 20), "NumericalView", 0,
-1e+10, 1e+10, 0, 'linear');
	NumericalView.new( w, Rect.newBy(252, 347, 64, 20), "NumericalView", 0,
-1e+10, 1e+10, 0, 'linear');
	RadioButtonView.new( w, Rect.newBy(9, 119, 128, 20), "slow1", 0, 0, 1, 0,
'linear')
		.group_(1);
	RadioButtonView.new( w, Rect.newBy(9, 143, 128, 20), "slow2", 0, 0, 1, 0,
'linear')
		.group_(1);
	RadioButtonView.new( w, Rect.newBy(9, 167, 128, 20), "slow3", 0, 0, 1, 0,
'linear')
		.group_(1);
	RadioButtonView.new( w, Rect.newBy(9, 191, 128, 20), "slow4", 0, 0, 1, 0,
'linear')
```

```
            .group_(1);
        RadioButtonView.new( w, Rect.newBy(9, 215, 128, 20), "slow5", 0, 0, 1, 0,
'linear')
            .group_(1);
        RadioButtonView.new( w, Rect.newBy(9, 239, 128, 20), "slow6", 0, 0, 1, 0,
'linear')
            .group_(1);
        RadioButtonView.new( w, Rect.newBy(9, 263, 128, 20), "slow7", 0, 0, 1, 0,
'linear')
            .group_(1);
        RadioButtonView.new( w, Rect.newBy(9, 287, 128, 20), "slow8", 0, 0, 1, 0,
'linear')
            .group_(1);
        RadioButtonView.new( w, Rect.newBy(9, 311, 128, 20), "slow9", 0, 0, 1, 0,
'linear')
            .group_(1);
        RadioButtonView.new( w, Rect.newBy(9, 335, 128, 20), "slow10", 0, 0, 1, 0,
'linear')
            .group_(1);
        RadioButtonView.new( w, Rect.newBy(142, 371, 76, 20), "no slow", 0, 0, 1,
0, 'linear')
            .group_(1);
        RadioButtonView.new( w, Rect.newBy(244, 119, 128, 20), "fast1", 0, 0, 1, 0,
'linear')
            .group_(2);
        RadioButtonView.new( w, Rect.newBy(244, 143, 128, 20), "fast2", 0, 0, 1, 0,
'linear')
            .group_(2);
        RadioButtonView.new( w, Rect.newBy(244, 167, 128, 20), "fast3", 0, 0, 1, 0,
'linear')
            .group_(2);
        RadioButtonView.new( w, Rect.newBy(244, 191, 128, 20), "fast4", 0, 0, 1, 0,
'linear')
            .group_(2);
        RadioButtonView.new( w, Rect.newBy(244, 215, 128, 20), "no fast", 0, 0, 1,
0, 'linear')
            .group_(2);


# go, s1x, s2x, sound1, sound2, sound3, recOn, rstart,
slow1x, slow2x, slow3x, slow4x, slow5x, slow6x, slow7x, slow8x, slow9x, slow10x,
slow0x,
fast1x, fast2x, fast3x, fast4x, fast0x = w.views;
offset1 = 0;
spd1 = 0;
trate = 1;
srate = 0.001;
sspd = - 0.1;
filename = ":Sounds:cas:ci2";
```

```
sound = SoundFile.new;
sound.read(filename);
signal = sound.data.at(0);
env = Env.linen(xfadelen, looplen - xfadelen, xfadelen, 0.85, \welch);
recbuf1 = Signal.newClear(Synth.sampleRate * 1);
threshhold = 0.1;
recStart = 0;

slow1 = SoundFile.new;
slow1.readHeader(":Sounds:cas:slow:slow1");
slow1.preloadData;
slow2 = SoundFile.new;
slow2.readHeader(":Sounds:cas:slow:slow2");
slow2.preloadData;
slow3 = SoundFile.new;
slow3.readHeader(":Sounds:cas:slow:slow3");
slow3.preloadData;
slow4 = SoundFile.new;
slow4.readHeader(":Sounds:cas:slow:slow4");
slow4.preloadData;
slow5 = SoundFile.new;
slow5.readHeader(":Sounds:cas:slow:slow5");
slow5.preloadData;
slow6 = SoundFile.new;
slow6.readHeader(":Sounds:cas:slow:slow6");
slow6.preloadData;
slow7 = SoundFile.new;
slow7.readHeader(":Sounds:cas:slow:slow7");
slow7.preloadData;
slow8 = SoundFile.new;
slow8.readHeader(":Sounds:cas:slow:slow8");
slow8.preloadData;
slow9 = SoundFile.new;
slow9.readHeader(":Sounds:cas:slow:slow9");
slow9.preloadData;
slow10 = SoundFile.new;
slow10.readHeader(":Sounds:cas:slow:slow10");
slow10.preloadData;
slow1.sustainLoopStart = 0;
slow1.sustainLoopEnd = slow1.numFrames;
slow2.sustainLoopStart = 0;
slow2.sustainLoopEnd = slow2.numFrames;
slow3.sustainLoopStart = 0;
slow3.sustainLoopEnd = slow3.numFrames;
slow4.sustainLoopStart = 0;
slow4.sustainLoopEnd = slow4.numFrames;
slow5.sustainLoopStart = 0;
slow5.sustainLoopEnd = slow5.numFrames;
slow6.sustainLoopStart = 0;
slow6.sustainLoopEnd = slow6.numFrames;
```

```
slow7.sustainLoopStart = 0;
slow7.sustainLoopEnd = slow7.numFrames;
slow8.sustainLoopStart = 0;
slow8.sustainLoopEnd = slow8.numFrames;
slow9.sustainLoopStart = 0;
slow9.sustainLoopEnd = slow9.numFrames;
slow10.sustainLoopStart = 0;
slow10.sustainLoopEnd = slow10.numFrames;

fast1 = SoundFile.new;
fast1.read(":Sounds:cas:fast:fast1");
sf1 = fast1.data.at(0);
fast2 = SoundFile.new;
fast2.read(":Sounds:cas:fast:fast2");
sf2 = fast2.data.at(0);
fast3 = SoundFile.new;
fast3.read(":Sounds:cas:fast:fast3");
sf3 = fast3.data.at(0);
fast4 = SoundFile.new;
fast4.read(":Sounds:cas:fast:fast4");
sf4 = fast4.data.at(0);

tgo2 = {n = rand(20);
if (n < 1, {trigger.value});
if (n == 2, {trigger2.value});
if (n == 4, {if (rand(50) == 1, {gonow.value})});
};
tgo = {if (rand(20) < 4, {trigger.value})};

trigger = {5.do({
arg i; w.at(i + 19).value = 0;i = i + 1});
11.do({
arg i; w.at(i + 8).value = 0;i = i + 1});
n = rrand(1, 20);
if (n == 1, {slow1x.value = 1});
if (n == 2, {slow2x.value = 1});
if (n == 3, {slow3x.value = 1});
if (n == 4, {slow4x.value = 1});
if (n == 5, {slow5x.value = 1});
if (n == 6, {slow6x.value = 1});
if (n == 7, {slow7x.value = 1});
if (n == 8, {slow8x.value = 1});
if (n == 9, {slow9x.value = 1});
if (n == 10, {slow10x.value = 1});
if (n >= 11, {slow0x.value = 1});
};
trigger2 = {11.do({
arg i; w.at(i + 8).value = 0;i = i + 1});
5.do({
arg i; w.at(i + 19).value = 0;i = i + 1});
```

```
n = rrand(1, 10);
if (n == 1, {fast1x.value = 1});
if (n == 2, {fast2x.value = 1});
if (n == 3, {fast3x.value = 1});
if (n == 4, {fast4x.value = 1});

if (n >= 5, {fast0x.value = 1});
};

pat = `([1,0,0,0,1,0,0,0,1,0,0,0,1,0,1,0,1,0,0,0,1,0,0,0,1,0,0,0,1,0,1,1]);
gonow = {offset1 = 0;spd1 = 110;s1x.value =1;trate = rrand(0.5, 3);};
inchange = {sound1.value = [0, 1].choose;sound2.value = [0, 1].choose;sound3.value
= [0, 0].choose;};
go.action = {gonow.value};
slowdown1 = {Spawn.ar({arg spawn;
offset1 = offset1 + spd1;
spd1 = spd1 + (sspd);
if (spd1 < 1, {spd1 = 1});
if (spd1 > 110, {spd1 = 110});
s2x.value = s2x.value + ((srate * (s1x.value + 1)) * 0.4);
if (s2x.value > 1.5, {srate = -0.00075 * trate; sspd = 0.05 * trate;});
if (s2x.value < 0, {srate = 0.001 * trate; sspd = -0.075 * trate; s1x.value = -1});
spawn.nextTime = looplen;
PlayBuf.ar(recbuf1, Synth.sampleRate, 1,
                    offset1, 0, recbuf1.size-2, EnvGen.ar(env))
                    })
          };

crunch = {Mix.arFill(1, {
BPF.ar(
               Decay2.ar(
                         ImpulseSequencer.ar(pat, t),
                         0.02, 1 / (q * 0.5) , slowdown1.value * 3),
                    LFNoise0.ar(r * 0.25, 5000, 25).abs,
                    LFNoise1.ar(q * 0.125, 0.5, 0.5).abs) * 4;


          })};


Synth.play({ arg synth;
r = Plug.kr(8);
          q = r * ((Latch.ar(BrownNoise.ar, Impulse.ar(r * 0.25)).abs) * (12 - (
s2x.kr * 2.5))).round(1);
          t = LFPulse.ar(q); // use a pulse wave as a trigger

slowout = Mix.ar([
Pause.ar({DiskIn.ar(slow1, true)}, slow1x.kr),
Pause.ar({DiskIn.ar(slow2, true)}, slow2x.kr),
Pause.ar({DiskIn.ar(slow3, true)}, slow3x.kr),
```

```
Pause.ar({DiskIn.ar(slow4, true)}, slow4x.kr),
Pause.ar({DiskIn.ar(slow5, true)}, slow5x.kr),
Pause.ar({DiskIn.ar(slow6, true)}, slow6x.kr),
Pause.ar({DiskIn.ar(slow7, true)}, slow7x.kr),
Pause.ar({DiskIn.ar(slow8, true)}, slow8x.kr),
Pause.ar({DiskIn.ar(slow9, true)}, slow9x.kr),
Pause.ar({DiskIn.ar(slow10, true)}, slow10x.kr)
]);

fastout = Mix.ar([
Pause.ar({PlayBuf.ar(sf1, fast1.sampleRate, 1, 0, LFNoise0.kr(t * 0.5 , 1,
0).abs.round(0.25) * sf1.size,
 LFNoise0.kr(t * 0.5, 0.75, 0.25).abs.round(0.25) * sf1.size)}, fast1x.kr),
 Pause.ar({PlayBuf.ar(sf2, fast2.sampleRate, 1, 0, LFNoise0.kr(t * 0.5 , 1,
0).abs.round(0.25) * sf2.size,
 LFNoise0.kr(t * 0.5 , 0.75, 0.25).abs.round(0.25) * sf2.size)}, fast2x.kr),
 Pause.ar({PlayBuf.ar(sf3, fast3.sampleRate, 1, 0, LFNoise0.kr(t * 0.5 , 1,
0).abs.round(0.25) * sf3.size,
 LFNoise0.kr(t * 0.5 , 0.75, 0.25).abs.round(0.25) * sf3.size)}, fast3x.kr),
 Pause.ar({PlayBuf.ar(sf4, fast4.sampleRate, 1, 0, LFNoise0.kr(t * 0.5 , 1,
0).abs.round(0.25) * sf4.size,
 LFNoise0.kr(t * 0.5 , 0.75, 0.25).abs.round(0.25) * sf4.size)}, fast4x.kr)



]);

in1 = {(BPF.ar(
Mix.ar(
	[slowout, slowout, fastout, fastout, AudioIn.ar([1, 2]) * 0.5]),
	//Lag.ar(Latch.ar(BrownNoise.ar(10000, 50).abs, Impulse.ar(LFNoise0.ar(1,
1.0, 0.5).abs)), LFNoise0.ar(1, 0.4, 0.1).abs),
	Lag.ar(LFNoise0.ar(LFNoise0.ar(1, 1.0, 0.5).abs,10000, 50).abs,
LFNoise0.ar(1, 0.4, 0.1).abs),
	Lag.ar(Latch.ar(BrownNoise.ar(1.0, 1.0).abs, Impulse.ar(LFNoise0.ar(1, 1.0,
0.5).abs)), LFNoise0.ar(1, 0.4, 0.1).abs)) ;
	) };
in2 = {AudioIn.ar(1) * 2};
in3 = {Decay.ar(Impulse.ar(4), 0.3, SinOsc.ar, 0)};

amp = Amplitude.kr(in2.value, 0.1) thresh: 0.05;
synth.repeat(0, 0.005, {

	if (amp.poll > threshhold && recStart == 2, {recOn.value = 1; recStart = 2},
{recStart = 0; recOn.value = 0});
	if (amp.poll > threshhold && recStart == 1, {tgo.value; recStart = 2;
recOn.value = 1}, {recStart = 0; recOn.value = 0});
	if (amp.poll > threshhold && recStart == 0, {recStart = 1; recOn.value = 1},
{recStart = 2; recOn.value = 1});
	if (amp.poll < 0.75 and: recStart == 1, {recOn.value = 1; recStart = 2;
tgo2.value});
```

```
        rstart.value = recStart;
        });

out = Mix.ar([in1.value * sound1.kr, in2.value * sound2.kr, in3.value * sound3.kr]);
RecordBuf.ar(recbuf1, out, 1, 0, 0, 1, 1);

LinXFade2.ar(
out, Mix.ar([slowdown1.value * 1 min: (1 - (s2x.kr)),crunch.value * 1 min:
((s2x.kr))]),
s1x.kr) + Mix.ar([AudioIn.ar([1, 2]), AudioIn.ar([1, 2])]);

});


w.close;
```

Rickety-Tick Code

```
var liveSound, delayedSignal, mousex;
var delayedSignal1, delayedSignal2;
var tapslider;
var proc, amp, on1, on2, freq, hasFreq, fp;

var filename, sound, signal, offset, lspd, env2, lp1;
var filename2, sound2, signal2, offset2, lp2, lspd2, rat1;
var offsetabs, lpabs, lspd3, lrange, explode;
var tgt1, state1, combine, getkeys, state2, tgt2, lrng;
var tapout, pat, filt, straight;
var sf;
var rcdat;
var pdata,method,campstream;
var mus, tap;
var bsignal,inp;
var cuts;
var rsl, dfile, rate, mult, bsignal2;

	var w;
	w = GUIWindow.new("panel", Rect.newBy(128, 64, 400, 400));
	SliderView.new( w, Rect.newBy(10, 13, 380, 24), "SliderView", 253.869, 1,
510, 0, 'linear');
	SliderView.new( w, Rect.newBy(10, 41, 380, 24), "SliderView", 253.009, 1,
510, 0, 'linear');
	SliderView.new( w, Rect.newBy(10, 69, 380, 24), "SliderView", 220.5, 1,
510, 0, 'linear');
	RangeView.new( w, Rect.newBy(10, 135, 381, 28), "RangeView", 0,
0.680636, 0, 1, 0, 'linear');
	ButtonView.new( w, Rect.newBy(6, 369, 21, 20), "k", 0, 0, 1, 0, 'linear');
	RangeView.new( w, Rect.newBy(10, 333, 381, 28), "RangeView", 60, 420, 1,
510, 0, 'linear');

	CheckBoxView.new( w, Rect.newBy(171, 204, 128, 20), "music", 0, 0, 1, 0,
'linear');
	CheckBoxView.new( w, Rect.newBy(171, 228, 128, 20), "tap", 0, 0, 1, 0,
'linear');
	CheckBoxView.new( w, Rect.newBy(171, 256, 128, 20), "fil", 0, 0, 1, 0,
'linear');
		CheckBoxView.new( w, Rect.newBy(171, 280, 128, 20), "straight", 1,
0, 1, 0, 'linear');

	CheckBoxView.new( w, Rect.newBy(250, 204, 128, 20), "delay", 1, 0, 1, 0,
'linear');
```

```
	CheckBoxView.new( w, Rect.newBy(250, 228, 128, 20), "chorus", 0, 0, 1, 0,
'linear');
LabelledSliderView.new( w, Rect.newBy(8, 200, 133, 40), "LabelledSliderView", 0,
0, 1, 0, 'linear');


# lspd, lspd2, lspd3, lrange, getkeys, lrng, mus, tap,filt, straight, on1, on2, rsl
 = w.views;
offsetabs = 0;
offset = 0;
	proc = Plug.kr(0);
offset2 = 0;
tapslider = 1;
state1 = Plug.kr(0);
tgt1 = Plug.kr(0);
state2 = Plug.kr(0);
tgt2 = Plug.kr(0);


sf= SoundFiles3.new.init([":Sounds:tloop82grev",":Sounds:tloop16grev"],[8,16]);

rcdat= RCutData.new([0,4,7,10,12,15,16],[0,1,2,3, 4,5,6, 3,4,5, 8,9, 7,8,10,
10],[3,4,1,5,3]);

pdata=[[0,2,4,6],[0,2,5],[0,2,6],[0,3,6],[0,4,6],[0,3,5],[0,2,4],[2,4,6],Array.new(0)];
method=
Pseq([Pseq([8],1),Pseq([0,1,0,2,0,2,0,3,0,4,0,5,0,4,0,6,0,4,0,5,0,4,0,3,0,2,0,2,0,1,0,7],i
nf)],1).asStream;
campstream= CampStream.new(pdata,method,16);

rat1=1;
pat = `([1,0,0,0,0,0,1,0,0,0,0,0,1,0,1,0,0,0,1,0,0,0,1,0,0,0,0,0,1,0,0,0]);
bsignal = Signal.newClear(Synth.sampleRate * ((sf.signal.at(0).size/44100) * 2));
bsignal2 = Signal.newClear(Synth.sampleRate * ((sf.signal.at(0).size/44100) * 2));
rate = 1;

	play({  arg synth;
		var looplen = 0.005, xfadelen = 0.0025, mx, my;
		var stream;
		var bbcs,bbcp;

	liveSound=AudioIn.ar([1, 2]);
# amp = Amplitude.kr(liveSound) thresh: 0.005;
# freq, hasFreq = Pitch.kr(liveSound);
fp = Plug.kr(440.0);
delayedSignal1 = CombN.ar(
		in: liveSound,
		maxdelaytime: 0.05,
		delaytime: 0.000025 max: (LFNoise0.kr(LFNoise1.kr(tapslider * 2.0,
2, 2).abs).abs * 0.5),
```

```
		mul: (LFNoise0.kr(LFNoise1.kr(tapslider, 2, 2).abs).abs) * 3);

	delayedSignal2 = DelayN.ar(
		in: delayedSignal1,
		maxdelaytime: 0.25,
		delaytime: (LFPulse.kr(tapslider, 0.5) * LFNoise1.kr(1)).abs,

		mul: delayedSignal1 * 3);

	a = Mix.ar([
	delayedSignal1 * 0.5
	,delayedSignal2 * 0.35
	,liveSound
	]);

mousex = LFNoise1.kr(1, 0.025).abs;
	delayedSignal = DelayN.ar(
		in: liveSound ,
		maxdelaytime: 0.075,
		delaytime: mousex,
		mul: 1);
	b = Mix.ar([liveSound, delayedSignal]) ;

x = LFNoise1.kr(LFNoise0.kr(1).abs * 2).abs + 0.01;
r = Plug.kr((2/(sf.signal.at(0).size/44100)) * 3);
q = r * ((Latch.ar(BrownNoise.ar, Impulse.ar(r * 0.125)).abs) * 8).round(1);
t = LFPulse.ar(q);

inp = Mix.ar([(a) * on1.kr, b * on2.kr, liveSound * 0.75]) * 2.0;

		f = Plug.kr( ((LFNoise1.ar(r * 0.25, 4).abs * rsl.kr).round(2)/r)).abs
*(bsignal.size);
		g = Plug.kr(( (  ((LFNoise1.ar(r * 0.25, 8.0 * rsl.kr).abs) ) + (8.0-(rsl.kr
* 8.0))).round(2)/r)).abs *(bsignal.size);

RecordBuf.ar(bsignal, inp * (1 - straight.kr),
 1.0, 0.0, (Latch.ar(BrownNoise.ar(1, 0.5),
		Impulse.ar(r * 0.5)) * (0.8 *LFNoise0.kr(r * 0.35).abs).round(1)) > 0.9,
		LFPulse.ar(LFNoise0.kr(r).abs * 2, (LFNoise0.kr(r * 0.5).abs *
2).round(0.5) * (1/r)),1);

RecordBuf.ar(bsignal2, inp,
 1.0, 0.0, 0,
	LFPulse.ar(LFNoise0.kr(r * 0.75).abs * 2, (LFNoise0.kr((r * 0.5) *1.5).abs *
2).round(0.5) * (1/r)),1);


thisSynth.tempo_(2/(sf.signal.at(0).size/44100));
```

```
SetTempo.kr(nil,MouseX.kr(2,3));
b = LFNoise1.ar(thisSynth.tempo).abs.round(1);
bbcp= MultiProc.new([WarpCutProc1.new,
RecCutProc.new(rcdat,8.0),

BBCutProc11.new
],nil,{(0 max: (3 - (state1.source * 2)).rand)});

bbcs=MultiBBCutSynth.new(
[
BBCutSynthParam.new(BBCSFastSF.new(sf,{2.rand})),
BBCSShortcut.playback(BBCutSynthSF.new(sf,{2.rand})),
BBCSPan1.new(BBCSEnv1.new(BBCSPhrase1.new(BBCSFilter1.new(BBCSPlayba
ck1.new(BBCSFilter1.new(BBCutSynthSF.new(sf, {2.rand})),0.9))))),
BBCutSynthParam.new(BBCSFastSF.new(sf,{2.rand}))
],nil,nil,{4.rand});
		combine = {
		tgt1.source = 220.5 / (52.1135/ 60);
		lspd.value = lspd.value + (((tgt1.source - lspd.value) * ((lrange.range)
* 0.0005)) / (1 - lrange.range));
		tgt2.source = 220.5 / (52.1135/ 60);
		lspd2.value = lspd2.value + (((tgt2.source - lspd2.value) *
((lrange.range) * 0.0005)) / (1 - lrange.range));

		if (lrange.range < 0.01, {tgt1.source = 0; state1.source = 0; lspd.value
= 220.5 / (52.1135/ 60);offset = 0;
		tgt2.source = 0; state2.source = 0; lspd2.value = 220.5 / (52.16/ 60);
offset2 = 0});

		};

		explode = {

		lspd.value = lspd.value + (((tgt1.source - lspd.value) * ((lrange.range)
* 0.0005)) / ( 1 - lrange.range));

		lspd2.value = lspd2.value + (((tgt2.source - lspd2.value) *
((lrange.range) * 0.0005)) / (1 - lrange.range));

		if (lrange.range < 0.01, {tgt1.source = 0; state1.source = 0;
		tgt2.source = 0; state2.source = 0});

		};

	lp1 =	Spawn.ar({ arg spawn;
			var env;

			offset = offset + (lspd.value * 1);

			looplen = 0.01;
```

```
				spawn.nextTime = looplen;


				env = Env.linen(xfadelen, looplen - xfadelen, xfadelen, 0.4,
\welch);

			Mix.ar([
				PlayBuf.ar(bsignal, Synth.sampleRate, 1,

				PlayBuf.ar(bsignal2, Synth.sampleRate, 1,
					offset, f, g, EnvGen.ar(env) * b.poll)

					])
				});

		lp2 =	Spawn.ar({ arg spawn;
				var env;

				offset2 = offset2 + (lspd2.value * 1);

				looplen = 0.01;

				spawn.nextTime = looplen;
				env = Env.linen(xfadelen, looplen - xfadelen, xfadelen, 0.4,
\welch);

			Mix.ar([
				PlayBuf.ar(bsignal, Synth.sampleRate, 1,
					offset2, f, g, EnvGen.ar(env)),

				PlayBuf.ar(bsignal2, Synth.sampleRate, 1,
				offset, f, g, EnvGen.ar(env) * b.poll)				])


			});


		lpabs = synth.trepeat(0, 0.005, {

					offsetabs = offsetabs + (220.05) ;
					if (state1.source == 1, {combine.value; });
					if (state1.source == 2, {explode.value; });
					if (offsetabs > (bsignal.size), {offsetabs =0});
					lrange.value = 0;
				lrange.range = (offsetabs / (bsignal.size));
				lspd2.value = lspd2.value + (0.5).rand2;

				if(rand(1.5) < 0.00025, {tgt1.source = rrand(lrng.value,
lrng.value + lrng.range).round(63.4672 *2.0);
```

```
                tgt2.source = [rrand(lrng.value, lrng.value + lrng.range).round(63.4672
*2.0), tgt1.source].choose; state1.source = 2;});
                if(rand(1.0) < 0.00125, {state1.source = 1;});

                if(hasFreq.poll == 1, {fp.source = freq.poll});
                getkeys.focus;
                        getkeys.keyDownAction_({arg asciiChar, keyCode, modifiers;

                var key;
                key = asciiChar;

                if (asciiChar == $1, {state1.source = 1;});
                if (asciiChar == $2, {tgt1.source = rrand(lrng.value, lrng.value +
lrng.range);
                tgt2.source = rrand(lrng.value, lrng.value + lrng.range); state1.source =
2;});
                if (asciiChar == $3, {lspd.value = rrand(lrng.value, lrng.value +
lrng.range);
                lspd2.value = rrand(lrng.value, lrng.value + lrng.range)});
                if (asciiChar == $z, {mus.value = (1 - mus.value)});
                if (asciiChar == $x, {tap.value = (1 - tap.value)});
                if (asciiChar == $c, {filt.value = (1 - filt.value)});
                if (asciiChar == $v, {straight.value = (1 - straight.value)});
                nil
                        });
        });


        m =  (0.5 + LFNoise1.kr(thisSynth.tempo * 0.25 max: (LFNoise1.kr(r,
0.65).abs.round(0.25)).abs).abs);
        n = (0.1 + LFNoise1.kr(thisSynth.tempo * 0.25 max: (LFNoise1.kr(r,
0.85).abs.round(0.25)).abs).abs);
        o = LFNoise1.kr(thisSynth.tempo, 0.25);



tapout =        Mix.ar([
Pan2.ar(
        PlayBuf.ar(sf.signal.at(1),sf.sound.at(1).sampleRate,sf.playbackspeed.at(1),0,0
,sf.signal.at(1).size, (1-filt.value) *(m*(1-n)).round(1)),o),

        BBCut.ar(bbcs, bbcp) * ((m*(n)).round(1))

        ]) * 0.75;


d =BPF.ar(
Decay2.ar(
                ImpulseSequencer.ar(pat, t),
                        0.02, LFNoise0.kr(q * 0.5).abs / (q), PitchShift.ar(tapout * 6,
0.05, 1.0 + ((LFNoise1.kr(q).abs * 2.0)))),
                        (fp.source *10) + (LFNoise0.ar(q).abs * 100),
```

```
                    LFNoise1.kr(q * 0.25, 1, 0.25).abs * MouseY.kr(0.25,
1.0))*(6.5*filt.kr);

        synth.trepeat(0, 0.05, {
if (amp.poll > 0.1, {proc.source = 5.rand});
if (proc.source == 0, {on1.value = 1}, {on1.value = 0});
if (proc.source == 1, {on2.value = 1}, {on2.value = 0});
if (proc.source > 3, {on1.value = 0; on2.value = 0});
        });

        Mix.ar([
        Mix.ar([
        Pan2.ar((lp1 ), 0.35 * LFPulse.kr(thisSynth.tempo * 0.75, 0.5)) * mus.kr,
        Pan2.ar(Reverb.simple(lp2 * 0.5,
        0.75, 0.25 + LFNoise0.kr(thisSynth.tempo, 0.75).squared),  (-0.65) *
LFPulse.kr(thisSynth.tempo * 0.75, 0.5)) * mus.kr
        ]),
tapout * tap.kr,
Reverb.simple(((inp*0.5) * straight.kr) * 0.5,
0.75, 0.25 + LFNoise0.kr(thisSynth.tempo, 0.35).squared),
(d * 4),
(inp*0.5) * straight.kr

        ])
        });
```

Hawaiian Code

```
var in, amp, freq, hasFreq, out;
var in2, amp2, freq2, hasFreq2, in3;
var tgt;
var n, t;
	var w;
	w = GUIWindow.new("panel", Rect.newBy(128, 64, 430, 291));
a=	SliderView.new( w, Rect.newBy(27, 16, 35, 200), "LabelledSliderView", 400,
0, 1000, 0, 'linear');
b=	SliderView.new( w, Rect.newBy(74, 16, 34, 200), "LabelledSliderView", 600,
0, 1000, 0, 'linear');
c=	NumericalView.new( w, Rect.newBy(150, 83, 64, 20), "NumericalView",
100, 0, 1e+10, 0, 'linear');
z=	NumericalView.new( w, Rect.newBy(4, 219, 64, 20), "NumericalView", 100,
0, 1e+10, 0, 'linear');
x=	NumericalView.new( w, Rect.newBy(74, 220, 64, 20), "NumericalView",
100, 0, 1e+10, 0, 'linear');
p=	NumericalView.new( w, Rect.newBy(150, 140, 64, 20), "NumericalView",
100, 0, 1e+10, 0, 'linear');
n = 190;
t = Wavetable.sineFill(512, [1]);
play({ arg synth;
d = BrownNoise.kr(1, 0.125) * 0.75;
y = 0.0;
	n.do({ arg i;
		y = Pause.ar({Osc.ar(t, 800, 0, 1, y)}, LFNoise1.kr(0.1 + (2.rand)));

	});
r=2;
tgt = Plug.kr(0);
in = AudioIn.ar(1);
	amp = Amplitude.kr(in, mul: 0.4);
	# freq, hasFreq = Pitch.kr(in);
	in2 = AudioIn.ar(2);
	amp2 = Amplitude.kr(in2, mul: 0.4);
	# freq2, hasFreq2 = Pitch.kr(in2);
	synth.trepeat(0.05, 0.005, {
	p.value = (z.value max: x.value) - (z.value min: x.value);
	if(p.value > 11, {p.value = p.value - 12});
	if(p.value == 0, {tgt.source = (z.value + 4).midicps});
	if(p.value == 1, {tgt.source = ((x.value min: z.value) - 4).midicps});
	if(p.value == 2, {tgt.source = ((x.value max: z.value) + 5).midicps});
	if(p.value == 3, {tgt.source = ((x.value max: z.value) + 1).midicps});
	if(p.value == 4, {tgt.source = ((x.value max: z.value) + 3).midicps});
	if(p.value == 5, {tgt.source = ((x.value max: z.value) + 3).midicps});
	if(p.value == 6, {tgt.source = ((x.value max: z.value) + 1).midicps});
```

```
        if(p.value == 7, {tgt.source = ((x.value max: z.value) + 4).midicps});
        if(p.value == 8, {tgt.source = ((x.value min: z.value) + 3).midicps});
        if(p.value == 9, {tgt.source = ((x.value min: z.value) + 5).midicps});
        if(p.value == 10, {tgt.source = ((x.value min: z.value) + 4).midicps});
        if(p.value == 11, {tgt.source = ((x.value min: z.value) + 7).midicps});
        c.value = c.value + d.poll;
        z.value = a.value.cpsmidi.round(1);
        x.value = b.value.cpsmidi.round(1);
        if (c.value < tgt.source, {c.value = c.value + exprand(0.5, 1.5)});
        if (c.value > tgt.source, {c.value = c.value - exprand(0.5, 1.5)});

        });

        in3 = Formant.ar(c.kr,500 + 1000* LFNoise1.kr((r * 0.25) * 0.65).abs,
        a.kr.cpsmidi.round(0.5).midicps,0.25 * LFNoise1.kr((r * 0.25)).abs);
out = Mix.ar([in*0.5, in2*0.5, in3, y*0]);
})
```

Latin Code

```
var env, outSound, myVoicer, filename, sound, signal, freq, hasFreq;
var file, file2, amp;
file = SoundFile.new;
file2 = SoundFile.new;
env = Env.new(
	levels: [0, 1, 1, 0],
	times: [0.005, 0.125, 0.275],
	curve: 'linear',
	releaseNode: 3);

	 filename = ":Sounds:stl:stlhit";
sound = SoundFile.new;
sound.read(filename);
signal = sound.data.at(0);
Synth.record({
				// this is the audio output signal of the voicer:
	outSound = Voicer.ar(
		{	arg voicer, i, synth, deltaTime,
			channel, note, note2;

			EnvGen.ar(env,

				PlayBuf.ar(signal, sound.sampleRate, note, 0, 0,
signal.size - 2)+
				PlayBuf.ar(signal, sound.sampleRate, note2, 0, 0,
signal.size - 2),
				timeScale: (1 / (note max: note2)),
				levelScale: 0.5
			);
	},
	numChannels: 1,
	midiChan: 1,
	maxVoices: 8
	);
				// You can access the voicer itself by
				// asking the output signal for its source.
				// For clarity, name that source myVoicer:
	myVoicer = outSound.source;
				// have the local synth (the synth that runs the synth
function here)
amp = Amplitude.kr(AudioIn.ar(2));

	thisSynth.repeat(
		0,
		0.0005,
```

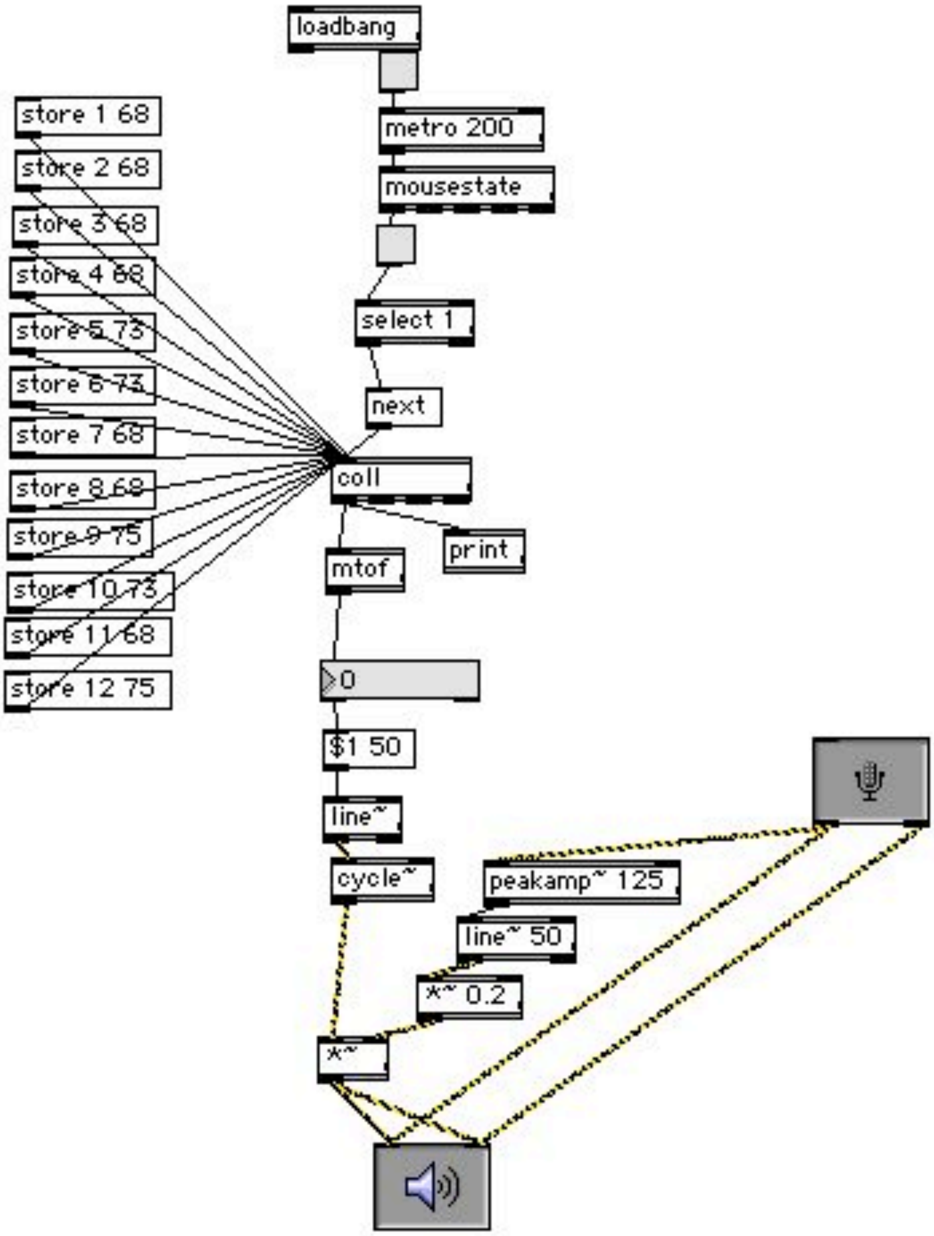
```
		userFunc:

		{	var randNote, randNote2;
			randNote = rrand(0.5, 3).round(0.125);
	// generate a random pitch
			randNote2 = rrand(0.5, 3).round(0.125);
	// and another

				// tell myVoicer to play a new note with the generated
				// random pitches every time userFunc is executed:
				if(amp.poll > 0.65, {
			myVoicer.noteDur(1, randNote, randNote2, 1)})
		}
	);

//(Gate.ar(outSound * 0.95,Pulse.ar((0.0001 max: LFNoise0.ar(1).abs) * 11025)))
(outSound * ( 0.2 +(LFNoise1.kr(0.65).abs * 0.25)))
 + Pan2.ar(AudioIn.ar(1) * 0.7, -0.65) +
		Pan2.ar(AudioIn.ar(2) * 1.2, 0.65)
}, 600.0, "steelband2", 'AIFF', '16 big endian signed');
```

Blues Code



loadbang
metro 200
mousestate
select 1
next
coll
print
mtof
store 1 68
store 2 68
store 3 68
store 4 68
store 5 73
store 6 73
store 7 68
store 8 68
store 9 75
store 10 73
store 11 68
store 12 75
0
$1 50
line~
cycle~
peakamp~ 125
line~ 50
*~ 0.2
*~

Appendix 2

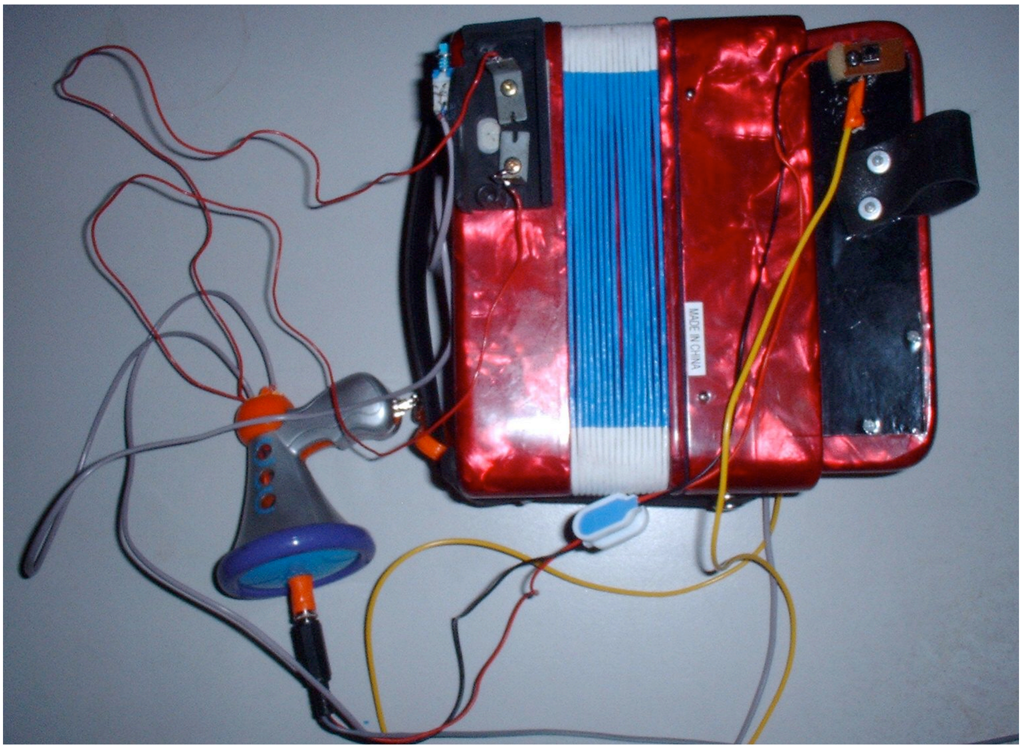


Figure 1 - Toy accordion and circuit-bent 'voice changer'.

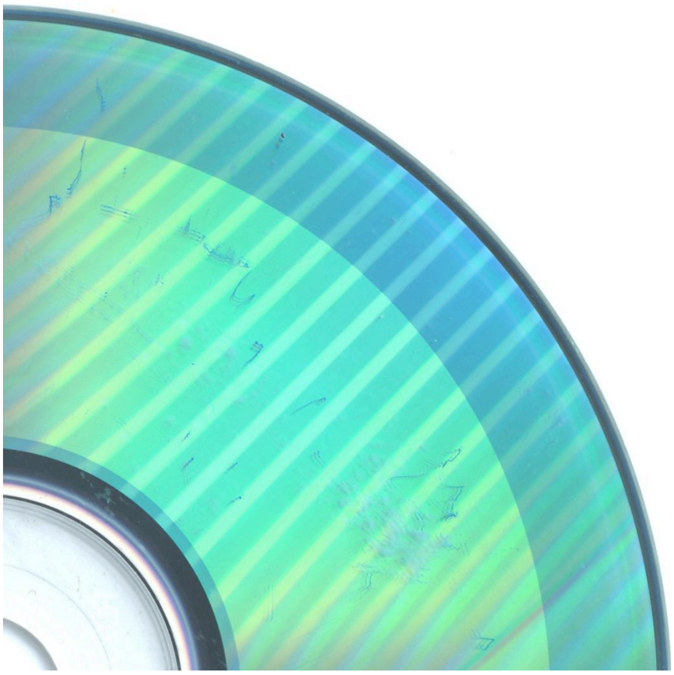


Figure 2 - Example of physical 'preparation' of an audio CD.

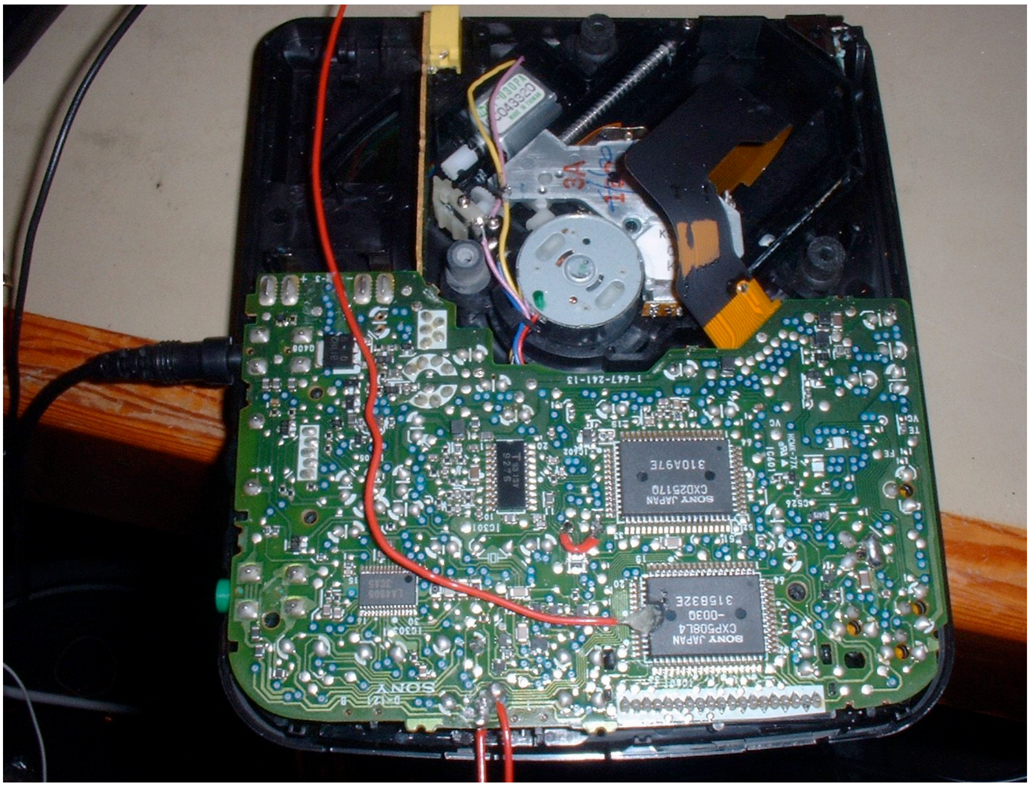


Figure 3 – Interior of a circuit-bent CD player. Red wires indicate my modifications.

Figure 4 – Hybrid toy piano and MIDI Sound Module.

Figure 5 - Hybrid 'Barcode Battler' and Yamaha VSS-220 keyboard.

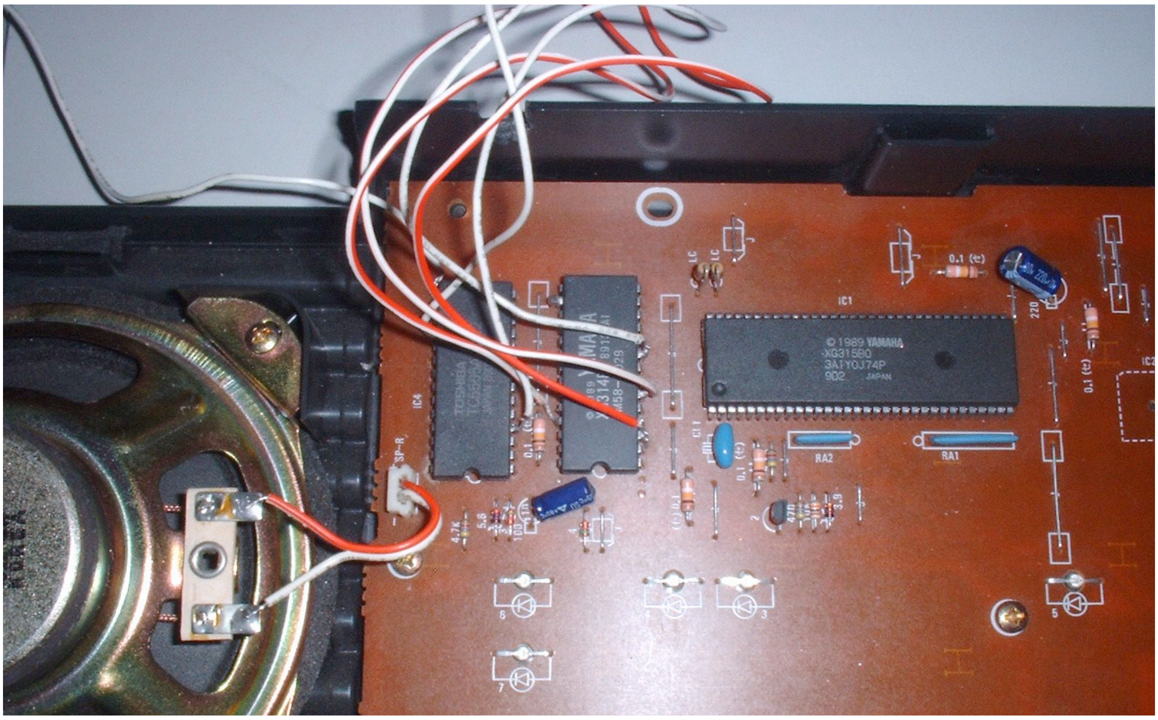


Figure 6 - Interior of a Yamaha PSS-380 keyboard. Wires protruding from circuit-board remain from discarded modification.

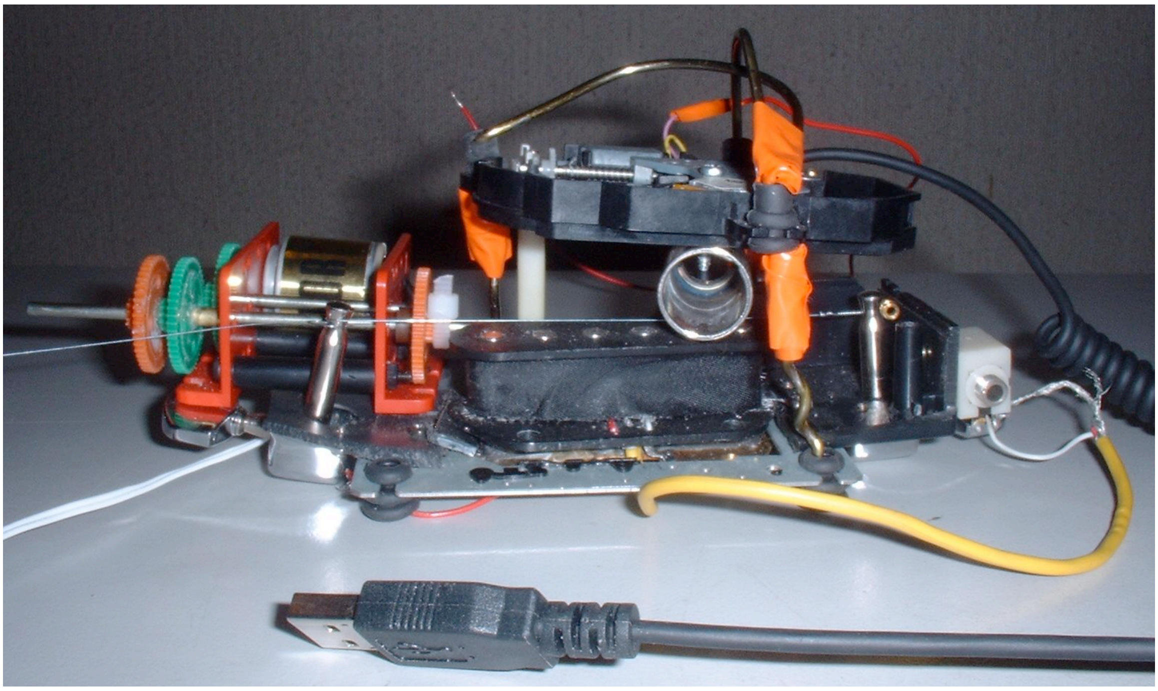


Figure 7 - Electro-mechanical 'slide guitar'.

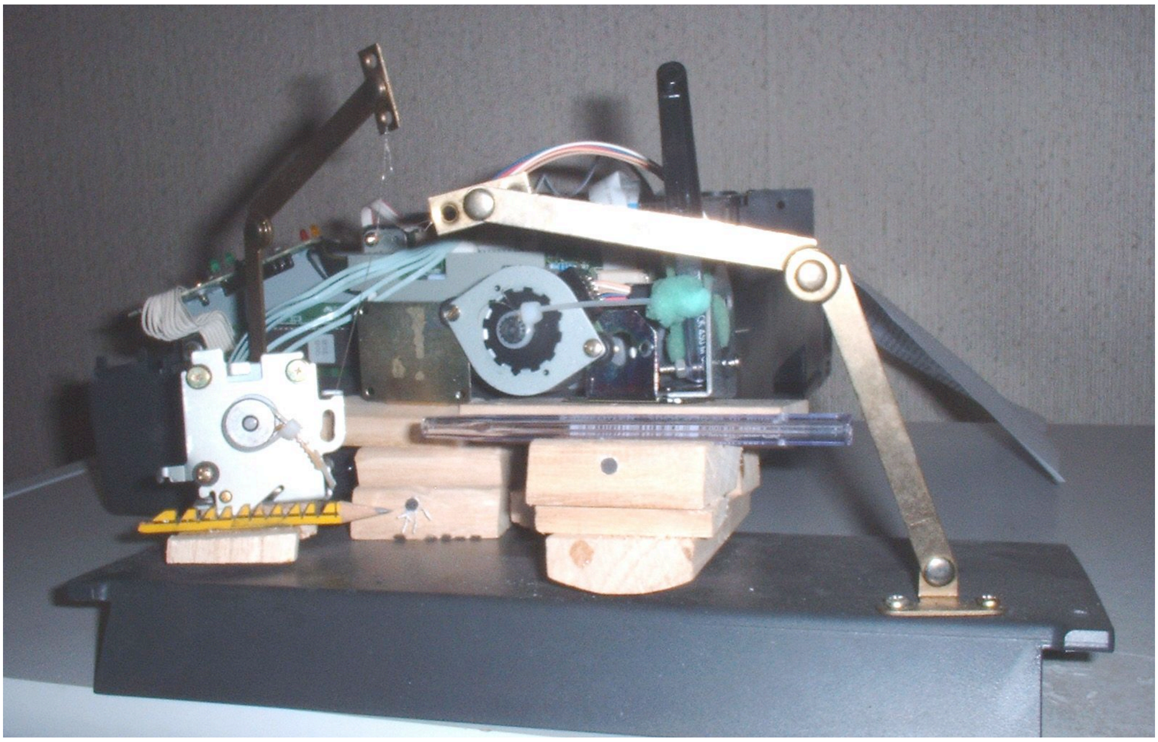


Figure 8 - Printer converted to percussion instruments.

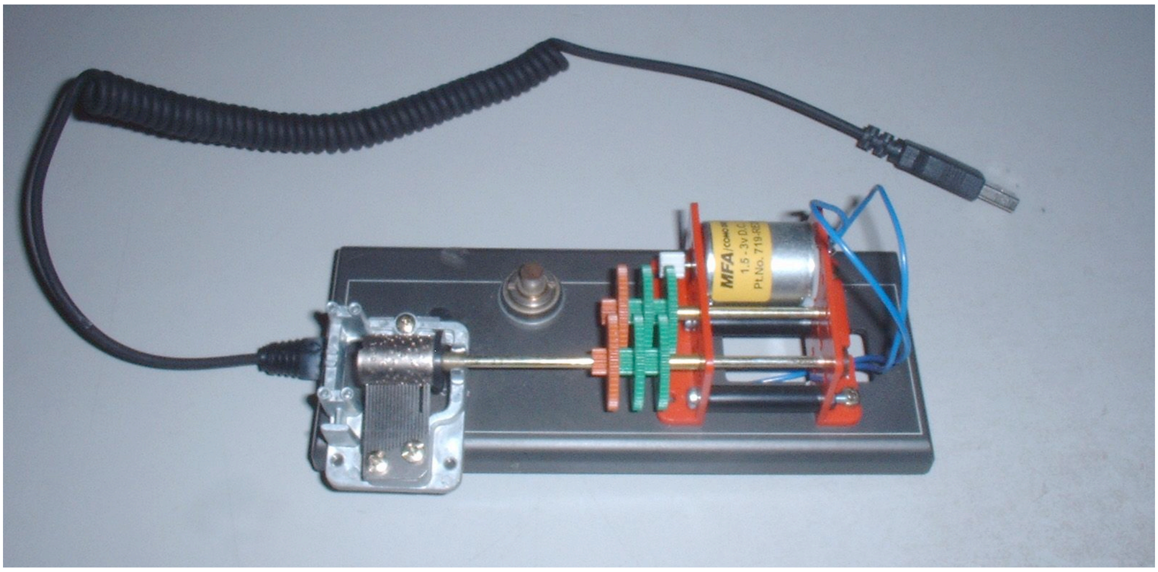


Figure 9 - USB powered music box.